DEPARTMENT OF THE ARMY — CORPS OF ENGINEERS

BEACH EROSION BOARD
OFFICE OF THE CHIEF OF ENGINEERS

BEACHES NEAR SAN FRANCISCO, CALIFORNIA 1956-1957

TECHNICAL MEMORANDUM NO. 110

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APRIL 1959

FOREWORD

The design of shore protection measures, including the artificial nourishment of beaches, is governed to a significant degree by the characteristics of the beach material in the problem area. These characteristics usually vary with time at any given point and also vary from point to point along and across the beach face. The collection and interpretation of a set of beach samples can be done more intelligently if the causes and probable extent of the variations in these beach characteristics are understood. Study of these variations in beach characteristics may also lead to a better understanding of shore processes in the littoral regime.

This report presents a summary of sand sample and foreshore profiles obtained at 2 to 6-week intervals over a 1-year period on ocean beaches in the vicinity of San Francisco. The data on Point Reyes Beach included in this report are from a continuation of about 2½ years of study from which data previously obtained were reported on in Beach Erosion Board Technical Memoranda Nos. 65 and 91.

This report was prepared at the Waves Research Laboratory of the Institute of Engineering Research at the University of California in Berkeley in pursuance of contract DA-49-055-Eng-8 with the Beach Erosion Board which provides in part for the study of beach materials. The author of this report, Parker D. Trask, is an engineering geologist at that institution.

Views and conclusions expressed in this report are not necessarily those of the Beach Erosion Board.

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by

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ABSTRACT

Eighteen profiles on beaches in the vicinity of San Francisco were occupied at intervals of 2 to 6 weeks from July 1956 to June 1957. Seven of these profiles were north of Golden Gate and eleven were south. The beaches vary greatly in character. Individual beaches differ from one another and the same beach differs from season to season and from place to place at any given time. The sand on the beaches tends to be relatively fine in the fall and coarse in the late winter or early spring. Individual beaches commonly build up during summer and fall and erode during winter and spring. The front of the berm may advance or retreat as much as 100 feet throughout the year. Point Reyes Beach has the coarsest and most poorly sorted sand. It also has the highest and most variable berm. Drakes Bay on the outer side of Point Reyes Peninsula has the finest and best sorted sand. The sand on beaches south of Golden Gate becomes progressively coarser southward. Average grain sizes for Point Reyes Beach are about 600 microns; for Drakes Bay and Stinson Beach, 220 microns; for the north end of Ocean Beach, 275 microns; and at Rockaway Beach 425 microns. The grain size at Point Reyes Beach is approximately twice as large in spring as in fall, and at many of the other beaches it is 50 percent greater in spring than in fall. The variability of sands found on individual beaches at any given period of occupation is greatest at Point Reyes Beach and least at Drakes Bay. The drift on Point Reyes Beach is predominantly from the northeast, but at times it comes from the southwest. Drift from both directions is indicated for other beaches, but the relative proportion coming from one direction or the other is not indicated. The tendency for waves on Ocean Beach to approach the shore at an angle from the south suggests a northward drift along this beach, during part of the year at least. Ocean Beach also loses considerable sand to the land by wind action.

INTRODUCTION

Effective control of beaches requires knowledge of the seasonal changes and the source, character, quantity, and transport of sand supplied. The profile and shape of beaches change from time to time. These changes depend on the addition and subtraction of sand on the beach. Each wave deposits a certain amount of sand as it rushes up the beach and erodes some sand as it rolls back down the beach. If beaches are supplied with adequate quantities of sand, which is more or less in equilibrium with the waves and with wave energy, the beaches neither erode nor build up; but if the supply of sand varies, while the wave conditions remain constant, or if the wave conditions vary while the supply remains constant, the beach changes its position and shape. It may erode seriously or it may advance seaward, depending on the relation between sand supply and wave pattern. In order to devise adequate measures for the protection of beaches, the laws of erosion, transport, and deposition of beach sand need to be known.

With this object in mind, the Waves Research Laboratory of the Institute of Engineering Research of the University of California has been making a study of the source and transport of sand on beaches in the vicinity of San Francisco, for the Beach Erosion Board. Point Reyes Beach, 35 miles north of San Francisco, was the first beach to be studied. This beach has been occupied at intervals of 2 weeks to 4 months since June 1953. The Beach Erosion Board has published two reports of this work.(1)

During the interval from July 1956 to June 1957, Point Reyes Beach and the fifteen other beach sections in the vicinity of San Francisco were occupied at intervals of 2 to 6 weeks with the object of determining the seasonal behavior of these beaches.

LOCATIONS OF PROFILES

The general locations of the beaches studied are shown on Figure 1. In previous work, profiles at arbitrary positions on the beaches were occupied at intervals of time. In all, eighteen beach profiles have been studied. Seven are north of Golden Gate. Their locations are

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(1) Trask, Parker D. and Johnson, Charles A. Sand Variation at Point Reyes Beach, California, Beach Erosion Board, Tech. Memo. No. 65, October 1955, 86 pages.

Trask, Parker D. Changes in Configuration of Point Reyes Beach, California, 1955-56, Beach Erosion Board, Tech. Memo. No. 91, 62 pages. This report contains an appendix by Parker D. Trask, Charles A. Johnson and Theodore Scott, "Cut and Fill on Point Reyes Beach, California, June 1953 to March 1954, 13 pages.

shown on Figure 2. Eleven are south of Golden Gate at locations indicated on Figure 3. The profiles are labeled by alphabetical symbols as given in Table 1.

To facilitate the presentation, beaches north and south of Golden Gate are called respectively Northern and Southern beaches. In particular profiles of Northern Beaches were located as follows: three on Point Reyes Beach, about 3 miles northeast of Point Reyes all in the vicinity of Station A shown on Figure 2, labeled AE, AO, and AW; Profile Q at Drakes Bay on the south side of Point Reyes Peninsula; and three profiles on Stinson Beach, about halfway between Drakes Bay and Golden Gate -- one labeled P at the west end of the beach, one labeled O in the middle of the beach and one labeled N at the east end near the State Park.

South of Golden Gate, five profiles are located within a distance of 0.5 mile at the north end of Ocean Beach. The northernmost of these profiles is Profile J, located just south of the rocks at the Cliff House. The other four profiles from north to south are Profiles I, H, G, and K. Two Profiles, profiles L and M, are located on Ocean Beach, 2.5 miles south of Profile K. Profiles E and F are located on a pocket beach at Sharp Park, about 7 miles south of Station M. The last two profiles, Profiles C and D are at Rockaway Beach, a pocket beach about 1.6 miles south of Profile E.

The profiles are tied into bench marks marked with stakes or other more permanent objects. The elevation of each bench mark has been estimated based on observations taken at low water, assuming that the elevations of low water, as predicted in the U. S. Coast and Geodetic Survey tide tables, are correct. It is believed the elevations are accurate to within 2 feet and probably within 1 foot. They are probably too high rather than too low. The zero mark for horizontal distances is taken at the bench mark, except for Profiles AE, AO, AW and E. At Point Reyes Beach, the zero mark for the three profiles is 101 feet north of a bench mark close to the edge of the beach cliff. At Profile E at Sharp Park the zero position is a cross mark upon a sewer outfall in the central part of the beach, 130 feet from the rear of the beach.

METHOD AND TIME OF SAMPLING

Samples were taken at horizontal intervals of 8 to 16 feet on Point Reyes beach and from 15 to 30 feet on other beaches. Each beach had the same sampling interval for all times of occupation, though the interval varied from one beach to another depending upon the general character of the beach. The interval of 8 to 16 feet was used on Point Reyes Beach in order to be consistent with the intervals used on previous studies of the beach, when a geometric interval between samples was chosen so that the pattern of areal variation of grain size could be studied statistically.

Dry or moist samples were collected in Kraft paper winged-ear seed envelopes provided with clasps on the wings to hold the envelope shut. Wet samples were collected in ice-cream cartons. As the glue on the seed envelopes disintegrated when the envelope became wet, they were not satisfactory for wet samples.

The samples were taken by scooping some 200 grams of sand either by hand or with the edge of an ice cream carton. As the beaches sometimes are laminated, some of the samples contain alternating layers of sand of different average grain size. As the mechanical analyses are made on the entire sample collected, the coefficient of sorting, as reported in Tables 7, 8 and 9, is somewhat greater than the sorting of the individual laminae studied. The beaches more commonly were uniform than laminated, at least to the lowest depth reached in taking the samples. As the average coefficient of sorting on Point Reyes Beach in the present series of samples is essentially the same as for the two previous periods of study of this beach, the conclusion is reached that the sorting has been determined with reasonable reliability, particularly when one considers the relatively high standard deviation of the samples on the beaches at the individual times of occupation. Study of the nature of lamination is beyond the scope of the present study, which is to determine the average composition of the beach sands at individual times and between different periods of occupation.

Most of the beaches had more or less well-developed cusps during some periods of occupation and no cusps during others: Point Reyes Beach always had cusps, averaging about 150 feet apart. The beach at no time showed the large embayments of the shore line, 1500 to 2500 apart, which were observed during some previous periods of occupation. Rip tides were observed at many times on Point Reyes Beach, but they were not seen at other times. The other beaches manifested no evidence of rip tides, but it does not necessarily follow that rip tides were not present.

The dates on which the profiles were occupied are given in Table 4. The times of occupation were near periods of full or new moon, when the tides were low. The profiles were made and the sand samples taken as near time of low water as possible. However as several beaches were occupied on any one day, the stage of the tide varied from one profile to another. The relative height of the tide at time of occupation can be estimated by the elevation of the seaward end of the individual profiles shown on Figures 4 to 21. A typical tide curve for San Francisco is shown in Figure 22.

MECHANICAL ANALYSES

Median Diameter

The data on mechanical analyses in this report are presented in the manner of Krumbein and Pettijohn[1] and Trask.[2] The mechanical analyses are made with standard sieves by shaking for 10 minutes in a rotap shaker. The sieve sizes vary by a factor of 2 or one-half the square root of 2. The weights of sand caught on the different sieves are plotted semi-logarithmically as a weight-accumulation curve in the standard manner. The quartile diameters representing the 10, 25, 50, 75, and 90 percentiles are recorded in microns, which are units representing 0.001 millimeter. The 50 percentile represents the diameter for which one-half of the weight of the sample is composed of particles larger than this diameter and one-half is composed of particles smaller than this diameter. This diameter is called the median diameter and is the best single figure to represent the nature of the sediment, as it represents an average diameter. The 25 and 75 percentiles are the first and third quartiles. They represent the mid-point of the size distribution of particles between the extreme diameters and the median diameter. The logarithmic scale is used in studying mechanical analyses statistically because the proportionate increase in diameter with respect to weight is more important than the arithmetic difference in grain size. When grain size diameters are treated statistically on an arithmetic basis anomalies result, but when they are treated in terms of the ratio of increase or decrease in diameter, normal statistical procedures can be used.

Phi Units

Because of the logarithmic relationships for differences in grain size, the diameters are customarily considered in terms of the logarithm of the diameters rather than the arithmetic size of diameter. Since sands customarily are classified in grades whose average diameters vary in size by factors of 2, the arithmetic size of the diameters is reported in terms of negative logarithms to the base 2. These negative logarithms are called Phi Units.[3] The critical diameter is one millimeter, or 1000 microns. The logarithm of one millimeter is 0; hence, the Phi diameter for this diameter is 0. A particle having a diameter of 0.5 millimeter, or 500 microns, has a Phi unit of 1.0; because 2 to the minus 1 power is 1/2. A Phi unit of 2.0 corresponds to 2 to the minus 2 power, or one divided by 4 or 1/4, or 0.25 millimeter, or 250 microns; and so on. Negative Phi units correspond to positive exponentials and thus to numbers larger than 1 millimeter. Thus a Phi diameter of -1.0 indicates a diameter of 2 to the first power, or 2.0 millimeters, that is 2000 microns; and a negative Phi diameter of 2.0 represents the square of 2, or 4.0 millimeters.

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(1) Krumbein, W. C., and Pettijohn, F. J., "Manual of Sedimentary Petrography", D. Appleton-Century Co., New York, 1938, pp. 136-274.
(2) Trask, Parker D., "Origin and Environment of Source Beds of Petroleum, Gulf Publishing Co., Houston, Texas, 1932, pp. 70-76.
(3) Krumbein, W. C., and Pettijohn, F. J., op. cit., p. 244.

To illustrate further the convenience of using Phi units, let us consider the following example. If the median diameter of one sand is 2000 microns and of another sand, 1000 microns, the Phi diameters respectively are -1.0 and 0. The difference between the two is 1.0 Phi unit. If we take another pair of sands, which like the first pair have median diameters at the extremes of one grade size, for example 1000 and 500 microns respectively, the corresponding Phi diameters are 0 and 1.0 respectively. The difference in Phi units is the same in both examples, whereas in terms of diameter in microns, the difference between the first pair is 1000 microns and between the second pair, 500 microns. These differences give false impressions of the real significance in the difference in grade size. If we consider these differences in terms of ratio of the larger to the smaller diameter, each is 2, which corresponds to a Phi diameter of 1. Similarly for statistical purposes a median diameter of 6/5 millimeters or 1200 microns, is comparable with a sand having a median of 5/6 millimeter, or 833 microns. On a ratio basis the product of 6/5 and 5/6 is 1.0 millimeter, but on a numerical basis the average is 1.017 millimeters. On a Phi unit basis the former diameter is -0.263 Phi units and the latter diameter, which is reciprocal of the former, is +0.263 Phi units. The difference is just one of sign.

Phi diameters, being negative logarithms to the base 2 are difficult to conceive in terms of numerical size. In order to facilitate the interpretation of Phi diameters in arithmetic units and vice versa, two conversion tables of one unit to the other are presented in Tables 2 and 3. Note that these tables are constructed in the manner of ordinary logarithm tables, but that in Table 2 the columns correspond to rows in Table 3. The data are presented in terms of four significant figures, except for diameters less than 100 microns in Table 2 which are given to three significant figures.

Standard Deviation

In order to interpret the significance of the averages, the standard deviation, sigma, of the averages is expressed in Phi units. The standard deviation is reported in two ways; one the standard deviation of the sample, the other, the standard deviation of the mean. The standard deviation of the sample is the square root of the mean of the sum of the squares of the differences between the median diameters of the individual samples and the mean of the samples. The standard deviation of the mean is the standard deviation of the sample divided by the square root of the number of samples used in computing the average. The standard deviation of the sample is a figure representing the general variation in grain size of the individual samples with respect to the mean. The standard deviation of the mean is an expression of the statistical reliability of the mean. Normally for a difference between two means to be significant, the difference should be at least twice as large as the average standard deviation of the individual means and preferably three times greater. Statistical procedures are available for computing the significance of the difference between means. These have been described in a previous report on Point Reyes Beach.[1] These procedures have not been used in the present report, but the basic data for applying them are given by the standard deviations presented in Tables 4 to 8.

As these standard deviations are presented in terms of Phi units, they are difficult to evaluate in terms of arithmetic units. The essential thing to remember is that they represent differences in ratios of samples of different median diameters. Thus in Table 3, the general average median diameter is 0.80 Phi unit, or 574 microns, and the standard deviation is 0.41 Phi unit. This indicates that 68 percent of the samples represented by the average of 0.80 Phi unit lie between a median diameter of 0.80 plus 0.41 and 0.80 minus 0.41 Phi unit; that is between Phi units of 1.21 and 0.39, which correspond to diameters of 432 and 763 microns. The ratio of the upper limit to the average diameter represented by 0.80 Phi unit is thus 763/574, or 1.33, and the ratio of the lower limit to average is 432/574, or 0.75. The ratio of 1.33 corresponds to 4/3 and the ratio of 0.75 to 3/4, which are reciprocal ratios. Expressed in terms of percentage the larger one represents a 33 percent increase over the average size, as the ratio is 1.33; whereas the smaller size is 1.00 minus 0.75 times 100 or 25 percent smaller than the median. However, the median is 33 percent greater than the smaller sigma limit. In order to show the relative significance of individual standard deviations, the percentage difference between the larger diameter represented by the standard deviation and the average diameter is expressed in terms of percent. Thus the figure of 33 percent for the average of 0.80 indicates that the ratio of the larger sigma diameter to the mean is 1.33. In order to determine the relative size of the variations a person may use either the Phi standard deviation or the percentage figures, which are also given in Tables 4, 5, 7 and 8. The percentage figures can be readily determined by comparing the Phi deviation with negative Phi units given in Table 2. For example a Phi deviation of -0.41 is readily seen to be 1330 microns in Table 2, which corresponds to 1.33 arithmetic units, or 33 percent greater than the mean.

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(1) Trask, P. D. and Johnson, C. A., op. cit.

The arithmetic of this relationship is simple as (mean) (sigma)/(mean) = sigma. The antilog of log sigma to the base 2, thus gives the standard deviation in the ratio form. As the data are given in Phi units, which represent the negative logarithm to the base 2, the corresponding ratio should be looked up in the negative Phi unit part of the Table, because two negatives made a positive.

Coefficients of Sorting and Skewness

The other statistical parameters used in the present study are the coefficients of sorting and the skewness. That of sorting is computed accordingly to the formula $(Q_3/Q_1)^{1/2}$ and that of skewness by $(Q_1 \cdot Q_3/M^2)^{1/2}$. The sorting coefficient is a dimensionless number larger than unity, and that of skewness is a similar number that ranges above and below unity. Since the skewness represents a ratio varying about unity, it generally is reported in the logarithmic form to the base 10. The sorting commonly is presented in terms of arithmetic units, and in the samples considered in the present study it ranges mainly between 1.10 and 1.50.. In most samples it lies between 1.25 and 1.30. The skewness ranges mainly between 0.95 and 1.05, and in most samples is close to unity. This common skewness of approximately 1.0 indicates that the distribution of the samples is symmetrical about the median diameter. Since the size distribution is so symmetrically arranged, no statistical studies of skewness have been presented in this report.

DESCRIPTION OF TABLES

Table 1 presents information describing the locations of the profiles.

Table 2 presents data for converting grain size measurements in Phi units to measurements in microns. Table 3 is an abbreviated table for converting microns to Phi units.

As Tables 2 and 3 were calculated to more significant figures than are shown in the tables, the problem arises as to the proper rounding of the last figure when the following significant figure is close to 5. In these tables when the last significant figure shown is 5, a line is placed beneath the five to indicate that the last significant figure has been revised upward to 5. Thus, in Table 2 the diameter corresponding to the Phi number of 0.99 is given in the table as 503.5, but with the next significant figure the number is 503.48. Thus in rounding off the 503.5 to an integer, the number is 503 and not 504. In like manner, the diameter corresponding to the Phi number of 0.14 is given in Table 2 as 907.5. This number to the next significant figure is 907.52, and if it is rounded to an integer the number is 908.

Table 4 presents the average median diameters in Phi units for different elevation zones, for different profiles, for different times of occupation . The table thus presents three variables: (1) elevation on beach; (2) position; and (3) time.

The elevation on the beach is presented in Table 4 and elsewhere in this report in terms of elevation zones. The mean values are given for the samples collected within the elevation limits of the individual zones, which as a rule are 3 feet. At station Q on the beach at Drakes Bay, the 9 to 12-foot elevation zone represents all samples lying landward of the 9-foot contour or the position of the edge of the berm. All samples in this latter zone at Drakes Beach are at least at an elevation of 8 feet. The reason for this procedure is to include in all elevation zones samples that are at successively greater distance from the ocean. As the beach here sometimes slopes downward toward land, a mathematical distinction of separating all samples according to elevation above the sea would give misleading impressions of samples collected on the upper foreshore and those collected on the berm or at a position more distant from shore than some intervening higher samples.

The last two columns in Table 4 give the mean of the median grain sizes for each zone for all times of occupation. One column gives mean diameter in Phi units, the other column gives it in corresponding microns. The Phi means represent the mean of all Phi diameters shown in individual rows.

Beneath the data for the average median diameters of the samples in the individual depth zones are figures for the average Phi diameter of all the samples collected along the individual profiles for each time of occupation. Figures are also given for all samples on the foreshore below the crest of the berm. These latter averages are labelled "Sub-berm". The values given represent the means of all samples on the individual profiles and the means of all foreshore samples, respectively. They are not the average of the means given for each elevation zone.

Data are given for the sub-berm samples because the samples collected from the sub-berm represent more or less a synoptic figure for the profile as a whole. Between individual tides the waves at some time or another wash up to the crest of the berm or nearly to the crest. The deposits on the foreshore thus represent more or less the results of the average wave conditions for a relatively short time interval. On the other hand the sands on the berms may have been deposited a considerable time previous to the occupation of the beach at some high stage of the waves. The sands on the berm are also affected by wind action, which blows finer sands away. Thus a sample of the whole beach may represent more than a single time period, and thus may not be truly representative of the conditions prevailing at or a short time previous to the period of sampling. Both averages are given as a matter of interest.

In order to indicate the general variability of the sands on the individual profiles at the time of sampling, data are presented for the standard deviation of the means for the entire profile and for the sub-berm. Figures are given also for the standard deviation of the mean of the sub-berm samples. These data are presented in terms of Phi units, and, as discussed before, represent the ratio of the standard deviation to the mean. To help interpret the relative reliability of the means and of the standard deviation of the means the number of samples used in the computation of the standard deviation is presented in the table.

In order further to help the interpretation of the statistical summaries of the beach population of grain size for the individual periods of occupation, data are given for the numerical size in microns for the mean of all the samples and for the mean of the sub-berm samples as explained above, data are given for the percentage deviation of the standard deviation. These percentage figures are given for the deviation of the high size rather than the low size with respect to the mean.

The three dimensional character of Table 4, presented on several pages, makes difficult the comparison of the relative effect of the individual variables affecting the size distribution. The salient features of Table 4 therefore have been summarized in Table 5. This table presents the average median diameter in Phi units for all periods of occupation of each profile. Each column representing an individual profile gives the averages presented in the second column from the right in Table 4.

Table 6 presents data on the average median diameter of the berm and sub-berm samples on the different profiles for the individual times of occupation. The data in this table represent figures for the respective averages for the berm and sub-berm presented on Table 4. These averages are compiled in two groups, one for the Northern Beaches and the other for the Southern Beaches. In this way the general nature of the individual beaches in the two geographic areas can be compared for each time of occupation. Table 6 also contains data on the mean Phi diameter and its arithmetic equivalent for each profile for all times of occupation. These general means thus indicate the general grain size for each beach profile studied. They are thus an indication of the average wave characteristics for each profile. But the averages, of course, are subject to a certain amount of unreliability, owing to the high standard deviation of the grain diameters for individual times of occupation.

Table 7 presents data on the coefficient of sorting in the same manner as given for the grain diameter in Table 4. The data however are presented in terms of arithmetic ratios, not in terms of logarithmic units as are the data in Table 4. Table 7 also contains data on the elevation of the berm for each time of occupation of the beaches, and for the distance in feet of the 10-foot or some other contour from the zero station for each time of occupation of each profile.

Tables 8 and 9 give data on sorting comparable to those for median diameter in Tables 5 and 6.

Table 10 supplies information on the average elevation of the berm for each profile for each time of occupation. These same data are presented in a different manner in Table 7 at the bottom of the tabulations for each profile. The berm elevation is taken directly from the respective profiles shown in Figures 3 to 21. If no berm was present at the time of occupation the word "none" is given. However, in Table 7 data are given for berm elevation for such periods of occupation. These elevations represent the average berm elevation for all periods when the beach had a berm.

Table 11 presents data on the advance and recession of the beaches on the individual profiles from one time of occupation to another. The reference point is the position of some elevation contour high on the foreshore. For stations AE, AO and AW on Point Reyes Beach, the position of the 10-foot contour is given. For Profile N at the east end of Stinson Beach, which is a lower beach, data are given for the position of the 8-foot contour; and for Profiles Q, at Drakes Bay, and Profiles P and O on the west end and the middle of Stinson Beach, which are still lower, the position of the 6-foot contour is given. On the Southern Beaches the position of the 10-foot contour is shown for all beaches except Profile J. This profile lies at the extreme north end of the beach. At this locality there was no berm during the 1956-1957 study period. The beach terminates against the sea wall and has a maximum height ranging between 6 and 9 feet. Thus, for Profile J the position of the 5-foot contour is given.

DESCRIPTION OF FIGURES

The general locations of the beaches under study are shown in Figure 1. More detailed position of the beaches north of Golden Gate is given in Figure 2 and of the beaches south of Golden Gate in Figure 3. Figures 4, 5 and 6 present beach profiles for the three lines on Point Reyes Beach, represented by Profiles AE, AO, and AW, respectively. These profiles are located at the old Coast Guard Station on Point Reyes Beach, and are 256 feet apart. Profile AE is the northeasternmost and Profile AW the southwesternmost. Each profile shows successive positions of the beach for each of five or six periods of occupation. The profiles at each time of occupation are indicated by appropriate description and line pattern. Note that the zero point for these profiles is a considerable distance north of the landward end of the profile as shown. The symbols "S" and "N" refer respectively to points south and north of the zero station.

Figure 7 shows the profiles of Line Q at Drakes Bay on the south side of the Point Reyes Peninsula for five periods of occupation. Figures 8, 9 and 10 represent profiles P, O and N respectively. These profiles are located on Stinson Beach, some 19 miles southeast of the profiles on Point Reyes Beach. They were occupied six times.

Figures 11 to 15 show beach position for Profiles J, I, H, G, and K, respectively. These profiles are distributed at intervals within a distance of slightly more than one-half mile at the north end of the beach in San Francisco. All except Profile J were occupied eight times. Profile J, at the extreme north end of the beach, was occupied seven times.

Figures 16 and 17, representing Profiles L and M, are located about 3 miles south of Profile J, near the Fleishhacker Zoo. Figures 18 and 19 represent Profiles F and E at Sharp Park, 9.8 miles south of Profile J. Note that the zero point on Profile E is midway up the beach. It is located on the top of a cement outfall sewer, 130 feet seaward from the upper edge of the beach. Figures 20 and 21, represent Profiles D and C on Rockaway Beach in the next pocket beach, about 1.6 miles south of Sharp Park. Figure 22 represents a typical tide curve for San Francisco and was taken from "Tide Tables 1959 - West Coast of North and South America", U. S. Department of Commerce, Coast and Geodetic Survey.

RESULTS

Median Diameter

Data on median diameters of the beach sands are given in Tables 4, 5 and 6. As shown in Table 6, the beaches fall into three main groups with respect to grain size. The first group includes the three profiles on Point Reyes Beach, which are exposed to the full sweep of the ocean waves. The sands on this beach are always highly variable, as is indicated by the large standard deviation of the samples and the difference in the general average grain size for the three profiles. The mean Phi diameter for these three profiles is 0.78, corresponding to 582 microns.

The other four Northern Beaches face the south. These are Profiles Q, P, O, and N. Profile Q on the southeast side of the Point Reyes Peninsula lies in the lee of Point Reyes. As a consequence the waves at this locality generally are small, usually around 2 feet in height, except of course during times of southwest storms, when they are much higher. Profiles P, O, and N are on Stinson Beach in the lee of San Francisco Bar. The waves here as a rule are around 2 or 3 feet in height. The average size of the sand on these four beaches increases progressively from 196 microns at Drakes Bay, to 235 microns at the southeast end of Stinson Beach at Profile N. The three profiles on Stinson Beach have about the same average grain size, but the means range from 206 microns on Profile P at the northwest end to 235 at the southeast end. All four locations exhibit relatively little difference in grain size throughout the year. The maximum is in April, when the general average for the four profiles is 243 microns, corresponding to a Phi diameter of 2.04 and the least is October and December when the mean diameter of the four beaches is 203 and 195 microns, respectively. Profile N at the southeast end of

Stinson Beach almost invariably is more coarse grained than the other profiles on Stinson Beach.

The Southern group of beaches, which lie south of Golden Gate over an interval of 11.5 miles, are intermediate in grain size between Point Reyes Beach and the beach at Drakes Bay. In general the grain size increases progressively from north to south; the average grain size at Profile J at the north end of the section is 272 microns and at Profile C and D on Rockaway Beach it is about 425 microns. The beaches for 1/2 mile south of Profile J are only slightly coarser than at Profile J, but the sand on the two profiles opposite Fleishhacker Zoo (Profiles L and M) is definitely coarser, averaging about 315 microns. Sharp Park Beach, 6.8 miles to the south averages 350 microns. The waves in general are gentlest at the northern end of the Southern Beaches and highest at Rockaway Beach at the south end. Evidently the bar off Golden Gate affects the height of the waves.

At Point Reyes Beach the sands are finest in October, when the average Phi diameter is 1.17, or 450 microns. February, with an average Phi diameter of 1.05 or 480 microns, is the period of next finest diameter. The coarsest period was in April, when the average Phi diameter was 0.46 or 725 microns. Other periods of coarse sand were December with a Phi diameter of 0.67 or 625 microns, January with a Phi diameter of 0.68 or 625 microns and August with a Phi diameter of 0.56 or 680 microns. These extremes are similar to the experience of former years. In the period 1955-1956 the extremes in grain size were Phi diameters of 0.38 in February and 0.84 in August, corresponding to 768 and 569 microns, respectively. In the years 1953 and 1954, the extreme Phi diameters were 0.48 in March and 0.90 in October, or 717 and 536 microns, respectively.

In the present study of Point Reyes Beach during the period 1956-1957, as well as in the two previous studies, the average grain size of the beach varied greatly from one period of occupation to another, evidently owing in some way to the character of the waves prevailing at the time. The finest sands invariably were encountered in October at the end of the long summer and the coarsest sands in the winter or spring. The extreme finest and coarsest sands were approximately the same from year to year. Similarly the averages for each of the three intervals of study were reasonably similar. The average Phi diameters for 1956-1957, 1955-1956, and 1953-1954 were 0.78, 0.63, and 0.61 respectively, corresponding to 582, 646, and 655 microns, respectively.

Variation of Sands on the Beach

Data on the standard variation, sigma, of the samples are given in Tables 4 and 5. Sigma was calculated for all samples on the beach and for samples on the foreshore, or sub-berm, as it is called in the tables. As a smaller distance is represented by the sub-berm than for the entire beach, the standard variation, in general, is slightly smaller for the sub-berm. As explained previously, the standard variation is expressed in Phi units, which in this particular case representsa ratio of the 84 percentile diameter to the mean diameter. That is 68 percent of the median diameters of the sands upon the individual profiles ranged within the mean diameter plus or minus sigma, that is between the 16 and 84 percentile diameters. In other words, the standard deviation represents the limits in grain size for the central two-thirds of the size distribution. Sigma is given to three significant figures, but owing to the great variation in grain size on the beaches, the third figure is of little significance. The average Phi sigma of the sands on Point Reyes Beach represented by profiles AE, AO, and AW is 0.396 or 32 percent. On other beaches north of Golden Gate represented by Profiles, Q, P, O, and N, Phi sigma is 0.210 or 16 percent -- the percentage variation being least 13 percent, at Drakes Bay, and greatest, 19 percent, at Profile N at the southeast end of Stinson Beach. On the beaches south of Golden Gate the general Phi sigma is 0.315, corresponding to 24 percent. The Southern Beaches show no particular variation in trend from north to south. The greatest Phi sigmas are 0.417 and 0.405 on Profiles I and C near the two ends of the series of the beaches and the least are 0.232 and 0.243 at profiles L and M at the south end of Ocean Beach near the Fleishhacker Zoo. These extremes correspond to 34 and 17 percent respectively. No relationship between sigma and median diameter is evident.

The average standard deviation of the mean median diameter on the three profiles on Point Reyes Beach is 0.12, or 9 percent. It is 0.045, 0.058, 0.058 and 0.078 on Profiles Q, P, O, and N respectively, or about 5 percent on the average. On the Southern beaches, the Phi sigma of the mean ranges from 0.074 on Profile L to 0.134 at Station C. The average for the Southern Beaches is 0.096, corresponding to 7 percent. Since the difference between two means should be at least twice the average standard deviation of the means in order for the difference to be significant, it is seen that no great reliance can be placed on the difference between the means of any two profiles in the same general area. The sand on Point Reyes Beach however is by far the coarsest, followed in turn by that on the Southern Beaches and the other beaches to the south and east of Point Reyes. The general progressive increase in grain size southward from Profile J on the Southern Beaches is of interest.

No variation with the season or period of occupation of the beach is evident. At the highly variable Point Reyes Beach, the standard deviation of the sands on the individual profile varies greatly at the same period of occupation. For example in August 1957, the Phi sigmas for Profiles AE, AO, and AF are 0.435, 0.694, and 0.327, with an average of 0.485 which incidentally is the highest average for Point Reyes Beach for any period in the present study.

The standard deviations of the samples on Point Reyes Beach during the periods of 1955 to 1956 and 1953 to 1954 are 0.34 and 0.37, respectively, compared with 0.40 in 1956 to 1957. The corresponding percentages for the 3 years are 27, 29, and 32, respectively. Thus the general variation of sand on the beach is essentially the same from year to year, even though it varies greatly from place to place at the same time and also at the same place from one month to another. It is interesting that Profile B, located 5.2 miles northeast of Station A on the central part of Point Reyes Beach, in 1953 had a standard variation of 0.59, or an average standard variation of 50 percent.

Comparison of Berm and Foreshore

The average grain size of all the samples on the individual beaches, as shown by Table 6, is essentially the same as the average grain size of the samples on the foreshore or sub-berm. The berm samples, as shown by Table 5, at some localities were coarser than the foreshore samples at some times and finer at other times. Likewise no consistent differences in grain size at successively higher positions on the beach is indicated by the data presented in Tables 4 and 5, except at Rockaway Beach at the south end of the area studied, where average grain size tended to decrease upward from the shoreline.

Sorting

Data on sorting are presented in Tables 7, 8, and 9. The general summary, shown in Table 9, shows that the sands on Point Reyes Beach at Station A are not particularly well sorted for beach sands, as the general average sorting for the 1956-1957 period is 1.30. Evidently this part of Point Reyes Beach has about the same average sorting from year to year, as the general average in the period 1953-1954 was 1.29 and in 1955-1956 was 1.28. This sorting however is considerably better than the sorting at Station B, which when it was occupied during the period of 1953-1954 averaged 1.45.

Profile Q on the south side of the Point Reyes Peninsula had the best sorted sediments of any of the beaches studied in the San Francisco area, as the coefficient of sorting of its sands averaged 1.18. The three profiles on Stinson Beach, represented by Profiles P, O, and N were intermediate in sorting between the sands on Point Reyes Beach and at Drakes Bay. The average sorting on Stinson Beach is 1.25. The sorting is poorest at the northwest end, at Station P, where the sorting is 1.26 and best on the southeast end at Station N, where the sorting is 1.24. However in consideration of the relatively high probable error of means, these differences in sorting on different parts of Stinson Beach should not be regarded as necessarily being distinctive.

The beaches south of the Golden Gate become progressively better sorted southward from Station J at the north end of Ocean Beach to Sharp Park, represented by Profiles F and E; and then become more poorly sorted at Rockaway Beach at the next profile 1.6 miles south of Sharp Park. The general average coefficient of sorting at Station J at the north end is 1.34. From here southward the sorting coefficient decreased progressively to 1.25 at Station K, about 1/2 mile south of Station J. From Station K to Station F at Sharp Park, over a distance of about 9.3 miles, the sorting is essentially the same. Profile E, 456 feet south of Profile F has an average sorting coefficient of 1.30, but in six of the eight times occupied, the coefficient of sorting averaged 1.26. It was generally high on two occasions, 1.40 in August, and 1.47 in April. The average sorting at Rockaway Beach, at the south end of the series of stations occupied is 1.32, which is about the same as at the north end of the series of Southern Profiles.

The sorting varies from season to season on the different beaches. At Station A on Point Reyes Beach the sorting is relatively good in October when the grain size of the sand is comparatively fine and the waves generally are low. It is relatively poor in the winter season when the sands are coarse and the waves high. The average sorting for the three profiles in October is 1.25 and in February it is 1.35. The beach at Drakes Bay (Profile Q) is much the same throughout the year. The sorting is best, 1.15 in October, but at other times it is close to 1.18. The beach was not occupied during February, when the sorting was poorest at Point Reyes Beach on the other side of the peninsula.

The sorting on Stinson Beach, represented by Profiles P, O, and N, on the whole is about the same from month to month, but in general it seems to be relatively good in summer and poor in winter. Similarly the beaches south of Golden Gate tend to be relatively well sorted in late summer and early autumn, and poorly sorted during late winter and early spring. The general average sorting, as represented by the medians of the Southern Beaches, shown at the bottom of Table 9, ranges from a low of 1.23 in August and September to a high of 1.32 in December and 1.33 in April. Note, however, that in February, the general average for these Southern beaches is 1.26, which is lower than the general average for all the beaches for all seasons, which is 1.29. It is thus obvious that the sorting on the beaches ranges considerably from time to time, presumably depending upon wave conditions.

The sorting likewise varies greatly from one part of a beach to another at any particular period of occupation. This variation is attested by the relatively high standard deviation of the samples on the individual beaches, as shown in Tables 7 and 8. On Point Reyes Beach, the general average standard deviation is 0.09, which means that on the average the sorting of two-thirds of the samples on the individual profiles, ranges between limits of 0.09 on either side of the mean of 1.30. That is, two-thirds of the coefficients of sorting lie between 1.21 and 1.39, and one-sixth are smaller and one-sixth are greater than these extremes.

If we compare the standard deviations of the sorting of the different beaches, one with another, we find that the range in sorting varies greatly from one beach to another. Hardly sufficient samples were collected at any individual occupation of any beach to give a reliable measure of the spread in sorting; but the consistently high standard deviations indicate that the sorting on these California beaches varies greatly from one sample to another.

The lowest standard deviation is on the beach at Drakes Bay at Station Q, where the general average is 0.05. The sands on Stinson Beach are more variable than even those on Point Reyes, because their general standard deviation is 0.12 compared with 0.09 on Point Reyes Beach. The Southern beaches likewise vary greatly in range of sorting. The lowest standard deviation is at Stations K, L, and M in the north central part of the beaches studied, and at Station F at Sharp Park, where the average standard deviation is about 0.07. This is midway between the deviation for Point Reyes Beach and the beach at Drakes Bay. The greatest range in sorting is at Stations J and I at the north end of the beaches studied and at Stations C and D and the south end. Here the average standard deviation is greater than 0.17. In general the range was least during the late summer and early fall and highest during the late winter and early spring, but no general consistency was observed, either as to successive times of occupation or from one beach to another. As mentioned above, the number of samples taken was too small to expect consistent results. The general trend of small range with low average sorting coefficients and high range with high coefficients however is obvious.

In previous studies of Point Reyes Beach, a general increase in coefficient of sorting, or decrease in degree of sorting was found in successively higher elevation zones, but the trend was not consistent and was marked by numerous exceptions. As shown by Table 8, the same general trend prevails at Point Reyes Beach, where the average sorting of the zones below 6 feet elevation is 1.26 compared with 1.31 above 9 feet. These are essentially the same figures as noted in previous studies. In all studies no great difference between the sorting on the upper part of the foreshore and on the berm was found.

Station Q on Drakes Bay similarly shows the same general trend. The sorting averages 1.14 in the lowest elevation zone and about 1.20 on the upper foreshore and berm. The stations on Stinson Beach, represented by Profiles P, O, and N, however, do not exhibit these same trends. As a matter of fact the data indicate that the berm samples are better sorted than the lower foreshore samples.

On the Southern Beaches no relation at all is indicated for sorting of the different elevation zones. The sorting varies in an inconsistent manner from one time of occupation to another and from one beach to another. The general average for the berm and sub-berm samples, as shown in Table 8, is essentially the same.

Berm Elevation

The elevation of the berm differs from one beach to another and also from time to time on the same beach. At some periods of occupation some of the beaches had no berm, or no berm was present along the line of the profile that was occupied, because the profile line was in the embayment between two cusps, or because the beach had no berm at that time. Table 10 presents data on berm elevation. The berm is highest at Point Reyes Beach (Station A), where it averages 16.8 feet for the entire period. This elevation is essentially the same as the elevation in the two previous periods of study of this beach. The berm elevation is relatively low in the summer and early fall, when it averages 16.4 feet and highest in December and April when it averages slightly over 17 feet. In February 1957, Profile AW had an old and high berm at an elevation of 18.2 feet, but a lower berm was forming about 2 feet lower at Profiles AO and AE. The berm elevation thus seems to be affected by wave characteristics, because it is relatively low during the season of high waves, but the general differences between seasons are less than 1 foot, a relatively small amount.

At Station Q on Drakes Beach, the average elevation of the berm is 8.3 feet. The berm was lowest in August when it was 7.3 and highest in October when it was 9.1. The seasonal difference at Station Q thus does not correspond with the seasonal differences at Station A.

The elevation of the berm on the three profiles on Stinson Beach, represented by Profiles P, O and N, is 8.5 feet. This is much the same elevation as at Drakes Beach. Station N at the southeast end of Stinson Beach has the highest average elevation, which is 9.6, and Station P at the northwest end of the beach has the lowest, 7.4 feet. The berm is lowest in August, 7.8 feet, and highest in December, 9.6 feet. The differences, hence, are not great.

The elevation of the berm on the Southern Beaches, in general, increases progressively from 11 feet at the north end to 13 feet at the south end. The berm is relatively low in August and high in February. In December and February, however, no berm was present at many stations. In December a berm was observed only at Stations L and M at Fleishhacker Zoo, but at no others. Evidently wave action in the winter is different from that in summer. The absence of the berm cannot be ascribed to the sea wall because the sea wall, at most places, is too far from the water line to affect wave action.

Advance and Retreat of Beaches

All of the beaches advance and retreat throughout the season. Graphical representation of the change in beach profile is shown in Figures 4 to 21, and tabular data are presented in Table 11. In Table 11, the position of some particular contour near the upper part of the foreshore is indicated for the different times the beach was occupied. The data given in Table 11 show the horizontal position of this contour relative to the zero point that is used for surveying the beach. These zero points are indicated in Table 1 and in Figures 4 to 21.

As shown by Table 11, Point Reyes Beach is a variable beach. The foreshore advances and retreats as much as 97 feet in the course of a year. The advances and retreats seem to be independent of the season. Part of the variability is due to shifting in position of the cusps from time to time. The data in Table 11 suggest that the beach is narrow in August and wide in January.

The beach at Station Q in Drakes Bay was narrowest in April and widest in August, almost the reverse of the situation at Station A on the other side of the peninsula. At Drakes Bay the maximum migration of the face of the beach is 126 feet. Stinson Beach in general followed the pattern of Drakes Beach. It advanced in August and retreated in February. The maximum shift during the period of study was 66 feet at Station P, at the west, 54 feet at Station O, in the middle, and 66 feet at Station N at the east end of the beach. Stinson Beach thus did not change in position as much as Drakes Beach and Point Reyes Beach.

The Southern beaches varied in much the same manner as the Northern Beaches, though some of them, notably the north end of Ocean Beach (Station I) and Rockaway Beach (Station D) were reasonably constant throughout the year. At Station I the maximum variation was 9 feet, and at D 36 feet. At the other profiles, J ranged through an interval of 45 feet; H, 37 feet; G, 65 feet; K, 95 feet; L, 37 feet; M, 32 feet; F, 70 feet; E, 46 feet; and C, 31 feet. The maximum range in beach profile thus is at Station K, a little over 1/2 mile south of the north end of this series of beaches. The beaches come and go in an irregular manner, and no seasonal trend is evident.

The changes in beach position perhaps are illustrated better by Figures 4 to 21. The berm on Profile AE on Point Reyes Beach was actively being eroded in August 1946, as is shown by the steep scarp on Figure 4. The berm seemingly did not erode back more than 25 feet during this period of erosion, because from October to April the front of the berm was reasonably constant, though the berm tended to build up seaward between February and April. On Profile AO, (Figure 5) the beach was being actively eroded in August, but from that time until some time shortly prior to April the beach continued to advance. In April it was cutting back, as indicated by the steep scarp for the profile for W day in April. The profile on U day in February was more gently sloping than at other days and extended much farther seaward. Profile AW (Figure 6) retreated progressively from August through October to December, and then advanced. As at Profile AO, the foreshore here sloped gently in February.

The beach at Drakes Bay represented by Profile Q (Figure 7) was remarkably constant throughout the summer and fall, but receded considerably by April. The late winter storms evidently moved considerable sand. Profile P (Figure 8) on Stinson Beach was relatively constant throughout the year, though the berm was about 1 foot lower in October than in August. As the wind blows vigorously at this part of Stinson Beach, the lowering of the berm may be due to wind erosion. Note that the lower foreshore of the beach in February is at its point of maximum recession. During the winter; tidal currents that bring water in and out of Bolinas Lagoon erode the foreshore at Station P, but the beach builds up during the spring and summer. Station O, midway on Stinson Beach (Figure 9) similarly builds up from August to October and erodes during the winter months, but the changes are not great.

Profile N (Figure 10) builds forward during the summer and early fall and erodes during the winter. The berm is essentially constant throughout the year. The waves evidently do not wash over the berm much during the year, though the front of the berm comes and goes.

The beach at Station J (Figure 11) at the north end of Ocean Beach varies greatly throughout the year. During the summer of 1956 no berm was present and the beach face did not change greatly. By November it had cut back somewhat but then began to move forward and upward throughout the rest of the period of study, reaching a maximum in June 1957, when it was at least 3 feet higher in all parts than it was during the low stage in November. During, and after the storms of March and April 1958, the beach built up at least 5 feet in some places and the shoreline was much farther seaward than is shown in Figure 11.

In previous years the beach at Station J evidently has been as much as 6 feet higher than shown in Figure 11, as is attested by remains of barbecue pits and similar stone installations on the sea wall. During the summer of 1956 these remnants were 5 to 6 feet above the level of the beach. A man interviewed at the site stated that these installations were level with the beach around 1940 but he did not know when they were washed away by the waves. Profile I (Figure 12) changed relatively little during the period of 1956-57. The beach had a well-defined berm at an elevation of about 12 feet during the summer and fall of 1956, but between November and December of that year the berm was destroyed and did not reform during the ensuing winter and spring. The beach was at its lowest elevation during December and then gradually filled reaching its maximum in June 1957, but the amount of fill was only 2 feet.

Station H, a short distance south of Station J, as mentioned above, does not change greatly with the season. The foreshore built up considerably in the late spring of 1957, as indicated by the high position of the lower foreshore shown on Figure 13. On the other hand the lower foreshore eroded materially between February and April of the same year. Station G, represented by Figure 14, had a constant berm during the summer of 1956, but the berm edge eroded considerably between July and November. The erosion continued during the winter and the berm reached its lowest point in February when it began to build up again.

Station K (Figure 15) about 1/2 mile south of Profiles J and I, is a highly variable beach. Its maximum advance was in July 1956 and its greatest recession in April 1957. In April and June, 1957 it had no berm. Station L (Figure 16) at the Fleishhacker Zoo, was reasonably stable from July through November. During this period the berm sloped backward away from the beach, but between September and November the depression on the berm filled in. Presumably few waves if any reached the berm during the summer months. The Beach eroded between November and February and then began to build up. By April it had risen 2 feet over its entire width. In June it had eroded back to a position comparable with the position of the previous summer.

Profile M (Figure 17) just south of Profile L had a similar history. The berm sloped backward during most of the year and was approximately constant during the summer, fall and winter, but in the spring rose nearly 3 feet. The front of the berm built progressively forward during the summer. In November a secondary berm was formed at an elevation of about 8 feet. When the beach was occupied for the first time, in July 1957, the front of the berm was steep. Evidently the berm was in the process of erosion at that time.

Profile F at Sharp Park varies considerably throughout most of the year, as shown by Figure 18. During the summer and early fall of 1956 it was fairly stable, but by November it had cut back so far that the berm was destroyed. Scarcely any berm was observed during the winter months. In fact the beach was pretty well cut back to the underlying well-indurated Pleistocene clay bedrock. The beach remained more or less constant during the winter, but between April and June filled about 4 feet over a stretch approximately 100 feet in width. Profile E (Figure 19) just south of line F at Sharp Park, similarly was more or less constant during the summer and fall, but by December had begun to erode. The minimum stage was reached in February. In April a low berm formed at an elevation of about 10 feet. By June this berm had been cut back. The beach at Station E (Figure 19) is much wider and more gently sloping than at Profile F. The profile at E does not seem to be controlled by bedrock as much as at F. The beach at Sharp Park frequently has cusps, which come and go with the season. Thus the profiles do not give a reliable representation of the average condition of the beach; they show what happens at some particular line. At a given time, one cusp can be building up and another cusp can be eroding.

Profile C (Figure 20) at Rockaway Beach, at the south end of the series of beaches studied, is a relatively steep beach. The waves are always comparatively high, evidently owing to some sort of refraction phenomenon. The beach position does not change much. A berm is present during summer but not during winter. Because of the concrete wall at the rear of the beach, a berm does not have much chance of forming during the winter season, when waves are strong. The beach maintained its maximum extent until December, when it began to cut back. It was at its minimum in June. The beach at Line D (Figure 22) at the south end of Rockaway Beach is steep and narrow. The concrete wall is continually attacked by waves and during the period of 1956-1957 the beach progressively eroded, reaching its lowest and steepest stage in June. The only time a berm was observed was in September near the end of the summer season.

CONCLUSIONS

The beaches in the vicinity of San Francisco are variable beaches. They vary not only from one season to another, but also from place to place on any given beach at any given time. Also, the beaches differ materially from one beach to another. These variations in character of individual beaches are ascribed largely to wave pattern. The chief seasonal variations in individual beaches are in grain size, sorting, height of berm, and position and shape of the foreshore. Some of the beaches always have cusps, others never, and some have cusps sometimes and not at other times. Though no consistent pattern is indicated for all beaches, most of the beaches build up during summer and fall, and erode during winter and spring. However, as wave height varies from one day to another, the beaches may build or erode at any time.

The beaches differ materially in average grain size. Point Reyes Beach, at Station A, 3 miles northeast of Point Reyes itself, is always relatively coarse grained. The average grain size is about 580 microns. The period of finest sand is in October when the average is 450 microns, and of coarsest sand, in April, when the average is 725 microns. These figures are comparable with grain sizes found on previous occupations of the beach between 1953 and 1956. The beach at Drakes Bay, across the peninsula from Point Reyes Beach, faces southeast and is in the shadow of Point Reyes. It has the most fine grained of the eighteen beach sands studied in the current investigation. The average grain size is approximately 200 microns. The grain size does not vary much throughout the year.

Sands on the three profiles on Stinson Beach, about midway between Drakes Bay and Golden Gate, are slightly more coarse grained than those at Drakes Bay, the average grain size being about 220 microns. This beach increases progressively in grain size from the western tip toward the east, but the differences are hardly sufficient to be statistically distinctive. The sands on Stinson Beach are slightly more coarse grained in the early spring than in the fall. The eleven beaches south of Golden Gate occupy a stretch of some 11 miles southward from the rocky promontory at the Cliff House in San Francisco. The average grain size increases more or less progressively from 275 microns at the north to about 425 microns at the south.

The average grade of the sand on the foreshore is essentially the same as the average for the entire profile, but the extremes in grade between spring and fall are greater for the foreshore than for the entire beach profile. In fact at Point Reyes Beach the foreshore sand is almost twice as coarse in spring as in fall.

The general variation of grain size on the individual beaches at any given time differs from one beach to another. The average standard deviation at Point Reyes Beach is about 30 percent, which is essentially the same variation as found in former years. This figure of 30 percent means that at any one period of sampling, some two-thirds of the sand ranged in grain size within 30 percent of the mean diameter and one-third of the sands differed in size by more than 30 percent. The percentage of variation at individual periods of occupation varied greatly from these figures throughout the year. Comparable figures for standard variation for other beaches are 17 percent for the south-facing beaches north of Golden Gate and 20 to 30 percent for the beaches south of Golden Gate. This great variability of most of the beach sands at all given times must reflect a complex pattern of wave characteristics as the waves roll up the beach.

The beaches do not show any general variation in sand grain size on individual parts of the beach. The grain sizes on both the berm and the foreshore are essentially the same. At some periods of occupation the sands on the lower part of the foreshore were coarser than near the crest of the foreshore, but no general trend was evident.

The sands on the beaches that were studied are only moderately well sorted for beach sands. The general average sorting on most of the beaches is 1.25 to 1.30. Drakes Bay has the best sorting. The average coefficient of sorting here is 1.18. This is one of the lowest beaches and it has the finest sand. The poorest sorting was at Station B five miles northeast of Station A on Point Reyes Beach. This beach was not studied during the present investigation, but when it was occupied during the season of 1953 to 1954, the average coefficient of sorting was 1.45, compared with 1.29 at Station A.

The sorting is about 10 percent better in the fall than in the spring, but this relationship is by no means consistent for all six beaches. The sorting also varies greatly on individual beaches at the same time. The standard deviation of the samples ranges generally between 0.05 and 0.15 of a sorting unit on the different beaches. It was less at Drakes Bay, where it was about 0.05, and greatest at the north and at the south ends of the beaches south of San Francisco Bay where it was more than 0.15. Owing to lamination of the beaches when some of the samples were taken, one would expect the observed sorting of the samples to be somewhat greater than the actual sorting of individual laminae.

The sorting on the berm is not materially different than the sorting on the foreshore, but sands on the lower part of the foreshore tend to be better sorted than on the upper part, but this generalization by no means holds for all periods of occupation of all the beaches.

The beaches as a rule build up during summer and fall and erode during winter and spring, but this generalization is also subject to exception. At Point Reyes Beach the position of the foreshore varied as much as 100 feet from one period of occupation to another; but at most of the other beaches the total variation was less than 50 feet. On two profiles, one at the north end of Ocean Beach in San Francisco and the other at Rockaway Beach, the total variation was about 25 feet.

The elevation of the berm varied throughout the year. In general the elevation is high in the fall and low during the late spring. At many of the beaches south of Golden Gate, no berm was present during the winter and early spring.

The direction of drift presumably varies on all the beaches. The great preponderance of chert and greenstone among the pebbles on Point Reyes Beach indicates that most of the beach material comes from the mainland northeast of the Point Reyes Peninsula, because no rocks of this character are found on the peninsula. As pebbles of more than a centimeter in diameter are sometimes found on the beach, the conclusion is obvious that these pebbles in some way have been transported across the mouth of Tomales Bay in water 5 to 10 feet deep. The presence of a few rounded pebbles of acid porphyry suggests very strongly, if not demonstrates, the migration of material from Point Reyes northeastward along the beach. The only known source of these prophyry pebbles is the Miocene conglomerate exposed on Point Reyes.

The sands at Drakes Bay give no indication of the source of material, though the presence of porphyry pebbles indicate an eastward drift, but the proportion of such eastward drift is not indicated.

The drift at Stinson Beach at times is from northwest to southeast, as numerous pebbles of Miocene rocks, which can only come from the northwest, are found along the beach. These pebbles have been transported across the mouth of Bolinas Lagoon in water at least 5 feet deep. The other rock materials however give no indication as to what proportion of the drift is from the opposite direction. The gradual diminution of grain size northwestward along the beach suggests a dominant westward drift. Similarly the general decrease in size northward along the Southern beaches suggests a dominant northward drift, but by no means demonstrates such a drift. The great amount of fill at the north end of Ocean Beach likewise suggests a northward drift, but the similar amount of erosion, by the same token could be due to a southern drift. Frequently the waves along this part of the beach come in at an angle from the south. Such waves should produce a northward current, which would transport sand toward the north. The beaches for a mile or more south of the Cliff House yield sand to the land, because at times considerable sand blows up through the stairways in the sea wall toward the hinterland. Also dunes pile up against the sea wall during the summer and late fall.

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Table 1. Location of Beach Profiles

Northern Beaches

Station	Coordinates Latitude N Longitude W	Location relative to reference point	Description
AO-O	38° 02' 11" 122° 59' 37"	Reference point	Point Reyes beach, below abandoned Naval Radio Compass Station, 3 miles NE of Point Reyes
AE-O	38° 02' 13" 122° 59' 36"	256 feet NE of station AO-O	Point Reyes beach
AW-O	38° 02' 09" 122° 59' 38"	256 feet SW of station AO-O	Point Reyes beach
Q-O	38° 01' 39' 122° 57' 35"	1.906 miles, bearing 108° from station AO-O	Drakes Beach Cove, south side of Point Reyes peninsula, on Drakes Bay
P-O	37° 54' 24" 122° 40' 35"	19.360 miles, bearing 117° from station AO-O	Northwest corner of Lot 124, Seadrift subdivision, Stinson Beach, Calif.
O-O	37° 54' 10" 122° 39' 08"	1.347 miles, bearing 101° from Station P-O	Southeast boundary of Seadrift subdivision, Stinson Beach, Calif.
N-O	37° 53' 49" 122° 38' 25"	2.083 miles, bearing 109° from station P-O	Fire road entrance to beach, Stinson Beach State Park, Stinson Beach, Calif.

Table 1 (continued)

Southern Beaches

Station	Coordinates Latitude N Longitude W	Location relative to reference point	Description
J-O	37° 46' 35" 122° 30' 38"	Reference point	North end of Ocean Beach seawall, Ocean Beach, San Francisco, Calif.
I-O	37° 46' 32" 122° 30' 36"	329 feet south of station J-O	Third staircase south of north end of seawall.
H-O	37° 46' 20" 122° 30' 37"	1506 feet south of station J-O	Fourth staircase north of auto ramp, center of seawall.
G-O	37° 46' 17" 122° 30' 37"	1825 feet south of station J-O	Second staircase north of auto ramp.
K-O	37° 46' 07" 122° 30' 36"	2874 feet south of station J-O	Fourth staircase south of auto ramp.
L-O	37° 44' 00" 122° 30' 22"	2.998 miles south of station J-O	Drift fence passageway, across highway from and in line with south wall of central portion of Fleishhacker Zoo swimming pool bathhouse, Ocean Beach
M-O	37° 43' 58" 122° 30' 22"	3.035 miles south of station J-O 252 feet south of station L-O	Second drift fence passageway south of passageway at Station L-O.
F-O	37° 38' 04" 122° 29' 36"	9.835 miles south of station J-O	Across beach road from second line of telephone poles north of curve in beach road, Sharp Park, California.
E-O	37° 38' 00" 122° 29' 37"	9.921 miles south of station J-O. 456 feet south of station F-O	Seaward end of concrete outfall structure, in line with first line of telephone poles north of curve in beach road, Sharp Park, California.
C-O	37° 36' 36" 122° 29' 46"	11.531 miles south of station J-O	Northwest corner of Rockaway Cafe parking lot, Rockaway Beach, California.
D-O	37° 36' 33" 122° 29' 37"	11.603 miles south of station J-O. 378 feet south of station D-O	Southwest corner of Rockaway Cafe parking lot, Rockaway Beach, California.

Table 2

Conversion of Phi Units to Microns

Phi Units

$+\phi$	0	1	2	3	4	5	6	7	8	9
					Microns					
0.0	1000.0	993.1	986.2	979.4	972.7	965.9	959.3	952.6	946.1	939.5
0.1	933.0	926.6	920.2	913.8	907.5	901.3	895.0	888.8	882.7	876.5
0.2	870.6	864.5	858.6	852.6	846.7	840.9	835.1	829.3	823.6	817.9
0.3	812.3	806.6	801.1	795.5	790.0	784.6	779.2	773.8	768.4	763.1
0.4	757.9	752.6	747.4	742.3	737.1	732.0	727.0	722.0	717.0	712.0
0.5	707.1	702.2	697.4	692.6	687.8	683.0	678.3	673.6	669.0	664.3
0.6	659.8	655.2	650.7	646.2	641.7	637.3	632.9	628.5	624.2	619.9
0.7	615.6	611.3	607.1	602.9	598.7	594.6	590.5	586.4	582.4	578.3
0.8	574.3	570.4	566.4	562.5	558.6	554.8	551.0	547.1	543.4	539.6
0.9	535.9	532.2	528.5	524.9	521.2	517.6	514.1	510.5	507.0	503.5
1.0	500.0	496.5	493.1	489.7	486.3	483.0	479.6	476.3	473.0	469.8
1.1	466.5	463.3	460.1	456.9	453.8	450.6	447.5	444.4	441.4	438.3
1.2	435.3	432.3	429.3	426.3	423.4	420.4	417.5	414.7	411.8	409.0
1.3	406.1	403.3	400.5	397.8	395.0	392.3	389.6	386.9	384.2	381.6
1.4	378.9	376.3	373.7	371.1	368.6	366.0	363.5	361.0	358.5	356.0
1.5	353.6	351.1	348.7	346.3	343.9	341.5	339.2	336.8	334.5	332.2
1.6	329.9	327.6	325.3	323.1	320.9	318.6	316.4	314.3	312.1	309.9
1.7	307.8	305.7	303.5	301.5	299.4	297.3	295.2	293.2	291.2	289.2
1.8	287.2	285.2	283.2	281.3	279.3	277.4	275.5	273.6	271.7	269.8
1.9	267.9	266.1	264.3	262.4	260.6	258.8	257.0	255.3	253.5	251.7
2.0	250.0	248.3	246.6	244.9	243.2	241.5	239.8	238.2	236.5	234.9
2.1	233.3	231.6	230.0	228.5	226.9	225.3	223.8	222.2	220.7	219.2
2.2	217.6	216.1	214.6	213.2	211.7	210.2	208.8	207.3	205.9	204.5
2.3	203.1	201.7	200.3	198.9	197.5	196.1	194.8	193.4	192.1	190.8
2.4	189.5	188.2	186.9	185.6	184.3	183.0	181.7	180.5	179.2	178.0
2.5	176.8	175.6	174.3	173.1	171.9	170.8	169.6	168.4	167.2	166.1
2.6	164.9	163.8	162.7	161.5	160.4	159.3	158.2	157.1	156.0	155.0
2.7	153.9	152.8	151.8	150.7	149.7	148.7	147.6	146.6	145.6	144.6
2.8	143.6	142.6	141.6	140.6	139.7	138.7	137.7	136.8	135.8	134.9
2.9	134.0	133.0	132.1	131.2	130.3	129.4	128.5	127.6	126.7	125.9
3.0	125.0	124.1	123.3	122.4	121.6	120.7	119.9	119.1	118.3	117.4
3.1	116.6	115.8	115.0	114.2	113.4	112.7	111.9	111.1	110.3	109.6
3.2	108.8	108.1	107.3	106.6	105.8	105.1	104.4	103.7	102.9	102.2
3.3	101.5	100.8	100.1	99.4	98.8	98.1	97.4	96.7	96.1	95.4

Underlined 5 means the true number is slightly less than 5

Table 2 (Continued)
Phi Units
(Note change of scale in Phi Units)

+Ø	0	1	2	3	4	5	6	7	8	9
3	125.0	116.6	108.8	101.5	94.7	88.4	82.5	76.9	71.8	67.0
4	62.5	58.3	54.4	50.8	47.4	44.2	41.2	38.5	35.9	33.5
5	31.3	29.2	27.2	25.4	23.7	22.1	20.6	19.2	17.9	16.7
6	15.6	14.6	13.6	12.7	11.8	11.0	10.3	9.62	8.97	8.37
7	7.81	7.29	6.80	6.35	5.92	5.52	5.15	4.81	4.49	4.19
8	3.91	3.64	3.40	3.17	2.96	2.76	2.58	2.41	2.24	2.09
9	1.95	1.82	1.70	1.59	1.48	1.38	1.29	1.20	1.12	1.05

Negative Phi Units
(Note change of scale in Phi Units)

-Ø	0	1	2	3	4	5	6	7	8	9
					Microns					
0.0	1000	1007	1014	1021	1028	1035	1042	1050	1057	1064
0.1	1072	1079	1087	1094	1102	1110	1117	1125	1133	1141
0.2	1149	1157	1165	1173	1181	1189	1197	1206	1214	1223
0.3	1231	1240	1248	1257	1266	1275	1283	1292	1301	1310
0.4	1320	1329	1338	1347	1357	1366	1376	1385	1395	1404
0.5	1414	1424	1434	1444	1454	1464	1474	1485	1495	1505
0.6	1516	1526	1537	1548	1558	1569	1580	1591	1602	1613
0.7	1625	1636	1647	1659	1670	1682	1693	1705	1717	1729
0.8	1741	1753	1765	1778	1790	1803	1815	1828	1840	1853
0.9	1866	1879	1892	1905	1919	1932	1945	1959	1972	1986
1.0	2000	2014	2028	2042	2056	2071	2085	2099	2114	2129
1.1	2144	2158	2174	2189	2204	2219	2235	2250	2266	2282
1.2	2297	2313	2329	2346	2362	2378	2395	2412	2428	2445
1.3	2462	2479	2497	2514	2532	2549	2567	2585	2603	2621
1.4	2639	2657	2676	2694	2713	2732	2751	2770	2790	2809
1.5	2828	2848	2868	2888	2908	2928	2949	2969	2990	3011
1.6	3031	3053	3074	3095	3117	3138	3160	3182	3204	3227
1.7	3249	3272	3294	3317	3340	3364	3387	3411	3434	3458
1.8	3482	3506	3531	3555	3580	3605	3630	3655	3681	3706
1.9	3732	3758	3784	3811	3837	3864	3891	3918	3945	3972
				(Note change of scale in Phi units)						
2	4000	4287	4595	4925	5278	5657	6063	6498	6964	7464
3	8000	8574	9190	9849	10556	11314	12126	12996	13929	14929
4	16000	17148	18379	19698	21112	22627	24251	25992	27858	29857
5	32000	34297	36758	39397	42224	45255	48503	51984	55715	59714

Table 3
Conversion of Microns to Phi Units

Microns	0	100	200	300	400	500	600	700	800	900
	Phi units									
00	9.966[1]	3.322	2.322	1.737	1.322	1.000	0.737	$0.51\underline{5}$[2]	0.322	0.152
05	7.644	3.252	2.286	1.713	1.304	0.986	$0.72\underline{5}$	0.504	0.313	0.144
10	6.644	3.184	2.252	1.690	1.286	0.971	0.713	0.494	0.304	0.136
15	6.059	3.120	2.218	1.667	1.269	0.957	0.701	0.484	0.295	0.128
20	5.644	3.059	2.184	1.644	1.252	0.943	0.690	0.474	0.286	0.120
25	5.322	3.000	2.152	1.621	1.234	0.930	0.678	0.464	0.278	0.112
30	5.059	2.943	2.120	1.599	1.218	0.916	0.667	0.454	0.269	$0.10\underline{5}$
35	4.836	2.889	2.089	1.578	1.201	0.902	0.655	0.444	0.260	0.097
40	4.644	2.836	2.059	1.556	1.184	0.889	0.644	0.434	0.252	0.089
45	4.474	2.786	2.029	1.535	1.168	0.876	0.633	$0.42\underline{5}$	0.243	0.082
50	4.322	2.737	2.000	$1.51\underline{5}$	1.152	0.862	0.621	0.415	0.234	0.074
55	4.184	2.690	1.971	1.494	1.136	0.849	0.610	0.405	0.226	0.066
60	4.059	2.644	1.943	1.474	1.120	0.836	0.599	0.396	0.218	0.059
65	3.943	2.599	1.916	1.454	$1.10\underline{5}$	0.824	0.589	0.386	0.209	0.051
70	3.836	2.556	1.889	1.434	1.089	0.811	0.578	0.377	0.201	0.044
75	3.737	$2.51\underline{5}$	1.862	1.415	1.074	0.798	0.567	0.368	0.193	0.037
80	3.644	2.474	1.836	1.396	1.059	0.786	0.556	0.358	0.184	0.029
85	3.556	2.434	1.811	1.377	1.044	0.773	0.546	0.349	0.176	0.022
90	3.474	2.396	1.786	1.358	1.029	0.761	0.535	0.340	0.168	0.014
95	3.396	2.350	1.761	1.340	1.014	0.749	$0.52\underline{5}$	0.331	0.160	0.007

Data for Negative Phi Units

Microns	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
Phi Units	0.000	0.138	0.263	0.379	0.485	$0.58\underline{5}$	0.678	0.766	0.848	0.926
Microns	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800
Phi Units	1.000	1.138	1.263	1.379	1.485	$1.58\underline{5}$	1.678	1.766	1.848	1.926
Microns	4000	4500	5000	5500	6000	7000	8000	9000	10000	20000
Phi Units	2.000	2.170	2.322	2.459	$2.58\underline{5}$	2.807	3.000	3.170	3.322	4.322

(1) Phi units for one micron.

(2) Underlined $\underline{5}$ means that the true number is slightly less than 5.

Table 4

Variations in Median Diameter of Elevation Zones
Profile AE Pt. Reyes Beach - East
(for locations of profiles see Table 1 and Figs. 1-3)

Elevation[1] Zones (feet)	M 15 Aug. 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean	Mean (microns)
			Time				
			Phi Units				
0-3	-	-	-	1.27	-	1.27	415
3-6	-0.08	1.46	0.47	1.58	0.09	0.70	616
6-9	1.03	1.55	0.75	1.31	0.52	1.03	490
9-12	1.00	1.63	0.45	1.25	0.51	0.87	511
12-15	-	1.13	0.62	0.56	0.60	0.73	603
15 +	0.65	0.76	0.60	0.77	0.52	0.66	633
			Averages				
All samples	0.73	1.23	0.61	0.95	0.48	0.80	574
Sub-berm	0.77	1.28	0.60	1.16	0.40	0.84	559
			Standard Deviation				
All samples	.435	.453	.240	.582	.329	.408	-
Sub-berm	.590	.485	.144	.403	.240	.372	-
Mean (sub-berm)	.178	.118	.040	.153	.091	.145	-
			Number of Samples				
All samples	19	21	31	16	18		105
Sub-berm	11	17	13	7	7		57
			Averages in Microns				
All samples	602	426	656	518	717	574	-
Sub-berm	586	412	660	448	758	559	-
			Standard Deviation in Percent				
All samples	36	37	18	50	26	33	-
Sub-berm	51	40	11	32	18	29	-
Mean (sub-berm)	13	8	3	11	6	11	-

(1) Above mean lower low water.

Table 4 (continued)

Profile AO - Pt. Reyes Beach - Center

	Time							
	M	O	Q	S	U	W	Mean	Mean
Elevation Zones (feet)	15 Aug 1956	13 Oct 1956	27 Dec 1956	15Jan 1957	13 Feb 1957	13 Apr 1957		(microns)
				Phi Units				
0-3	-	-	-	0.44	1.49	-	0.97	511
3-6	-0.47	1.31	-	0.53	1.60	-0.03	0.59	664
6-9	0.02	1.38	0.25	0.46	1.34	0.19	0.61	665
9-12	1.05	1.41	0.26	0.81	0.38	0.12	0.67	629
12-15	0.59	1.30	0.49	0.81	1.01	0.77	0.83	563
15 +	0.63	0.77	0.80	0.87	0.89	0.69	0.78	582
				Averages				
All samples	0.34	1.14	0.67	0.68	1.05	0.40	0.71	611
Sub-berm	0.23	1.35	0.42	0.58	1.15	0.19	0.65	637
				Standard Deviation				
All samples	.694	.316	.292	.404	.562	.426	.449	-
Sub-berm	.795	.246	.170	.395	.481	.428	.419	-
Mean (sub-berm)	.213	.066	.054	.106	.139	.104	.114	-
				Number of Samples				
All samples	20	21	20	22	20	29	132	-
Sub-berm	14	14	10	14	12	17	81	-
				Averages in Microns				
All samples	790	454	628	624	483	758	611	-
Sub-berm	854	393	747	669	451	877	637	-
				Standard Deviation in Percent				
All samples	62	24	22	32	48	34	37	-
Sub-berm	74	19	13	31	40	35	34	-
Mean (Sub-berm	16	5	4	8	10	8	8	-

Table 4 (continued)

Profile AW - Pt. Reyes Beach - West

Elevation Zones (feet)	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr. 1957	Mean	Mean (microns)
			Phi Units				
0-3	-	-	-	1.42	-		
3-6	-0.63	1.27	-	1.50	-0.55	0.39	763
6-9	0.67	1.36	0.55	-	0.14	0.68	624
9-12	0.53	1.49	0.63	0.95	0.38	0.80	574
12-15	0.68	1.27	0.76	0.95	0.33	0.80	574
15 +	0.72	0.73	0.84	1.15	0.79	0.85	555
			Averages				
All samples	0.60	1.13	0.75	1.15	0.49	0.82	566
Sub-berm	0.52	1.32	0.64	1.15	0.25	0.78	582
			Standard Deviation				
All samples	.327	.349	.297	.240	.446	.332	-
Sub-berm	.379	.235	.182	.240	.437	.295	-
Mean (sub-berm)	.109	.063	.058	.067	.165	.092	-
			Number of Samples				
All samples	19	20	20	13	13	82	-
Sub-berm	12	14	10	13	7	52	-
			Average in Microns				
All samples	660	457	595	451	712	566	
Sub-berm	697	401	642	451	841	582	
			Standard Deviation in Percent				
All samples	25	27	23	18	36	26	
Sub-berm	30	18	13	18	35	23	
Mean (Sub-berm)	8	5	4	5	12	7	

Table 4 (continued)

Profile Q - Drake's Cove

Time

	K	M	O	Q	W	Mean	Mean (microns)
Elevation Zones (feet)	2 Aug 1956	15 Aug 1956	13 Oct 1956	27 Dec 1956	13 Apr 1957		
			Phi Units				
0-3	-	2.47	2.51	2.43	-	2.47	180
3-6	2.34	2.41	2.51	2.31	2.14	2.34	198
6-9	2.24	2.35	2.55	2.36	2.28	2.36	195
9-12(1)	2.27	2.20	2.39	2.29	2.81	2.39	191
12-15	-	-	-	-	-	-	-
15 +	-	-	-	-	-	-	-
			Averages				
All samples	2.28	2.36	2.46	2.34	2.31	2.35	196
Sub-berm	2.27	2.40	2.53	2.38	2.24	2.36	195
			Standard Deviation				
All samples	.147	.139	.155	.124	.318	.177	-
Sub-berm	.124	.103	.078	.080	.274	.132	-
Mean (sub-berm)	.039	.033	.028	.022	.104	.045	-
			Number of Samples				
All samples	16	16	16	20	8	75	
Sub-berm	10	10	8	13	7	48	
			Averages in Microns				
All samples	206	195	182	197	202	196	
Sub-berm	207	189	173	192	212	195	
			Standard Deviation in Percent				
All samples	11	10	11	9	25	13	-
Sub-berm	9	7	6	6	21	10	-
Mean (sub-berm)	3	2	2	2	8	3	-

(1) Includes samples on berm at elevation of 8 to 9 feet.

Table 4 (continued)

Profile P - Stinson Beach - West

Time

	K	M	O	Q	S	U	W	Mean	Mean (microns)
Elevation Zones (feet)	2 Aug 1956	15 Aug 1956	13 Oct 1956	27 Dec. 1956	15 Jan 1957	13 Feb 1957	13 Apr 1957		
Phi Units									
0-3	-	-	2.10	2.46	-	2.57	1.97	2.28	206
3-6	2.35	2.22	2.49	2.40	-	2.46	2.20	2.35	196
6-9	2.43	2.35	2.25	2.26	-	2.13	2.21	2.27	207
9-12	2.09	-	2.39	2.35	-	2.14	1.88	2.17	222
12-15	-	-	-	-	-	-	-	-	-
15 +	-	-	-	-	-	-	-	-	-
Averages									
All samples	2.35	2.28	2.31	2.39	-	2.31	2.05	2.28	206
Sub-berm	2.38	2.20	2.37	2.44	-	2.45	2.05	2.32	200
Standard Deviation									
All samples	.177	.153	.258	.113	-	.266	.284	.208	-
Sub-berm	.154	.126	.232	.107	-	.165	.361	.191	-
Mean (sub-berm)	.040	.042	.077	.032	-	.055	.104	.058	-
Number of Samples									
All samples	21	13	15	17	-	15	16	97	-
Sub-berm	15	9	9	11	-	9	12	65	-
Average in Microns									
All samples	196	206	202	191	-	202	242	206	-
Sub-berm	192	218	193	184	-	183	242	200	-
Standard Deviation in Percent									
All samples	13	11	20	8	-	20	22	15	-
Sub-berm	11	9	17	8	-	12	29	14	-
Mean (Sub-berm)	3	3	5	2	-	4	8	4	-

Table 4 (continued)

Profile O - Stinson Beach - Middle

	Time							
	K	M	O	Q	U	W	Mean	Mean (microns)
Elevation Zones (feet)	2 Aug 1956	15 Aug 1956	13 Oct 1956	27 Dec. 1956	13 Feb 1957	13 Apr 1957		
				Phi Units				
0-3	2.35	-	-	2.09	2.21	2.30	2.24	212
3-6	2.21	2.17	2.23	2.51	2.24	2.25	2.27	207
6-9	2.27	2.24	2.56	2.40	2.14	1.66	2.21	216
9-12	2.03	2.01	2.17	2.30	2.07	1.76	2.06	240
12-15	-	-	-	-	-	-	-	-
15 +	-	-	-	-	-	-	-	-
				Averages				
All samples	2.20	2.13	2.26	2.37	2.19	1.95	2.18	221
Sub-berm	2.20	2.18	2.38	2.39	2.20	2.06	2.24	212
				Standard Deviation				
All Samples	.133	.194	.261	.184	.110	.322	.201	-
Sub-berm	.133	.195	.155	.204	.123	.312	.187	-
Mean (Sub-berm)	.033	.059	.052	.055	.041	.111	.058	-
All samples	16	15	14	18	10	12	80	-
Sub-berm	16	11	9	14	9	8	67	-
				Average in Microns				
All	218	228	209	193	219	259	221	
samples	218	221	192	191	218	240	212	
				Standard Deviation in Percent				
All samples	10	14	20	14	8	25	15	
Sub-berm	10	15	11	15	9	24	14	
Mean (Sub-berm	2	4	4	4	3	8	4	

Table 4 (continued)

Profile N - Stinson Beach - East

Time

Elevation zones (feet)	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean	Mean (microns)
				Phi Units				
0-3	-	-	-	2.55	2.23	-	2.39	191
3-6	2.45	2.27	2.43	2.49	1.95	2.06	2.28	206
6-9	2.25	2.44	2.45	2.44	1.66	1.38	2.10	233
9-12	2.00	2.05	2.09	2.14	2.12	1.72	2.02	247
12-15	2.20	-	-	-	2.27	2.12	2.20	218
15 +	-	-	-	-	-	-	-	-
				Averages				
All samples	2.14	2.19	2.16	2.31	2.02	1.75	2.09	235
Sub-berm	2.34	2.34	2.37	2.50	1.92	1.73	2.20	218
				Standard Deviation				
All samples	.215	.272	.186	.218	.302	.336	.255	-
Sub-berm	.128	.187	.150	.155	.354	.264	.206	-
Mean (Sub-berm)	.045	.054	.067	.047	.107	.147	.078	-
				Number of Samples				
All samples	20	21	19	23	18	15	116	-
Sub-berm	8	12	5	11	11	7	54	-
				Averages in Microns				
All samples	227	219	224	202	247	297	235	
Sub-berm	197	197	193	177	264	301	218	
				Standard Deviation in Percent				
All samples	16	21	14	16	23	26	19	
Sub-berm	9	14	11	11	28	20	15	
Mean (Sub-berm)	3	4	5	3	8	11	6	

Table 4 (continued)

Profile J - North End of Ocean Beach, San Francisco

Time

Elevation zones (feet)	J 27 July 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
				Phi Units					
0-3	2.15	-	2.25	1.46	2.32	1.50	1.36	1.84	279
3-6	2.23	2.37	1.95	0.72	2.05	0.69	2.04	1.72	304
6-9	2.12	2.47	-	-	1.82	0.84	2.24	1.90	268
9-12	-	-	-	-	-	-	-	-	-
12-15	-	-	-	-	-	-	-	-	-
15 +	-	-	-	-	-	-	-	-	-
				Averages					
All samples	2.19	2.39	2.05	1.49	2.12	1.01	1.91	1.88	272
Sub-berm	2.19	2.39	2.05	1.49	2.12	1.01	1.91	1.88	272
				Standard Deviation					
All samples	.069	.066	.203	.723	.234	.351	.340	.284	-
Sub-berm	.069	.066	.203	.723	.234	.351	.340	.284	-
Mean (sub-berm	.031	.033	.107	.295	.078	.203	.094	.120	-
				Number of Samples					
All samples	5	4	3	6	9	3	13	43	-
Sub-berm	5	4	3	6	9	3	13	43	-
				Averages in Microns					
All samples	219	191	242	356	230	497	266	272	
Sub-berm	219	191	242	356	230	497	266	272	
				Standard Deviation in Percent					
All samples	5	5	15	65	18	28	27	22	-
Sub-berm	5	5	15	65	18	28	27	22	-
Mean (Sub berm)	2	2	8	23	6	15	7	9	-

Table 4 (continued)

Profile I - 329 feet South of Profile J

Time

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
					Phi Unit					
0-3	-	-	-	1.72	2.17	2.32	2.19	1.18	1.92	264
3-6	2.34	2.35	1.54	1.54	1.38	0.15	0.32	1.12	1.34	395
6-9	2.25	2.06	2.22	1.84	1.40	1.35	1.92	1.76	1.85	277
9-12	2.08	1.85	2.04	1.69	1.40	1.76	1.60	1.76	1.77	293
12-15	1.94	1.90	2.06	1.84	-	-	1.72	-	1.89	272
15 +	-	-	-	-	-	-	-	-	-	-
					Averages					
All samples	2.21	2.10	1.99	1.71	1.74	1.39	1.51	1.43	1.76	295
Sub-berm	2.25	2.15	1.98	1.71	1.74	1.39	1.51	1.43	1.77	293
					Standard Deviation					
All samples	.190	.273	.309	.157	.391	.832	.797	.391	.417	-
Sub-berm	.167	.277	.335	.157	.391	.832	.797	.391	.418	-
Mean (sub-berm)	.048	.098	.106	.056	.118	.240	.240	.109	.127	-
					Number of Samples					
All samples	14	10	12	8	11	12	11	13	91	-
Sub-berm	12	8	10	8	11	12	11	13	85	-
					Averages in Microns					
All samples	215	233	252	206	299	382	351	371	295	-
Sub-berm	210	225	253	206	298	382	351	371	293	-
					Standard Deviation in Percent					
All samples	14	21	24	11	31	78	74	31	34	
Sub-berm	12	21	26	11	31	78	74	31	34	
Mean (sub-berm)	3	7	8	4	9	18	18	8	9	

Table 4 (continued)

Profile H - 1177 feet South of Profile J

	Time									
Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
	Phi Units									
0-3	-	-	-		1.86	1.81	2.07	1.65	1.85	277
3-6	2.19	2.25	2.27	2.20	0.26	1.76	1.56	1.69	1.77	293
6-9	2.02	2.27	2.29	1.78	1.45	1.56	1.56	1.78	1.84	279
9-12	1.87	1.87	2.26	1.98	1.98	1.84	1.78	1.51	1.89	270
12-15	1.64	1.79	-	1.60	2.00	1.81	1.10	1.40	1.62	325
15 +	1.99	-	-	-	-	-	1.51	1.71	1.74	299
	Averages									
All samples	1.96	2.04	2.28	1.68	1.35	1.75	1.61	1.62	1.79	289
Sub-berm	2.12	2.24	2.26	1.92	1.18	1.73	1.75	1.68	1.86	275
	Standard Deviation									
All samples	.249	.298	.100	.343	.784	.130	.360	.228	.312	-
Sub-berm	.124	.088	.097	.270	.832	.134	.244	.185	.247	-
Mean (Sub-berm)	.039	.033	.029	.090	.215	.051	.082	.056	.074	-
	Number of Samples									
All samples	17	11	12	11	19	9	14	18	111	-
Sub-berm	10	7	11	9	15	7	9	11	79	-
	Averages in Microns									
All samples	257	243	206	312	392	297	328	325	289	-
Sub-berm	230	212	209	264	441	302	297	312	275	-
	Standard Deviation in Percent									
All samples	19	23	7	27	72	9	28	17	24	
Sub-berm	9	6	7	21	78	10	18	14	19	
Mean (Sub-berm)	3	2	2	6	16	4	6	4	5	

Table 4 (continued)

Profile G - 319 feet South of Profile H

Time

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
				Phi Units						
0-3	2.25	-	-	-	1.70	1.34	1.84	1.73	1.77	293
3-6	2.21	2.26	2.15	1.65	1.39	0.55	1.88	2.03	1.77	293
6-9	2.09	2.26	2.35	1.59	1.70	1.28	1.12	1.91	1.79	289
9-12	1.72	1.82	2.04	1.62	2.14	1.79	1.58	1.73	1.81	285
12-15	1.56	-	-	1.85	2.02	1.74	1.22	1.19	1.60	330
15 +	1.84	-	-	-	1.82	-	1.66	1.76	1.77	293
				Averages						
All samples	1.89	2.06	2.19	1.66	1.73	1.31	1.56	1.75	1.77	293
Sub-berm	2.06	2.20	2.23	1.59	1.69	1.13	1.71	1.90	1.81	285
				Standard Deviation						
All samples	.297	.295	.178	.227	.307	.582	.301	.372	.320	-
Sub-berm	.201	.105	.118	.233	.303	.606	.248	.264	.260	-
Mean (Sub-berm)	.061	.040	.034	.078	.073	.192	.082	.080	.080	-
				Number of Samples						
All samples	17	9	13	13	20	14	17	18	121	-
Sub-berm	11	7	12	9	17	10	9	11	86	-
				Averages in Microns						
All samples	270	240	219	316	301	403	339	297	293	-
Sub-berm	240	218	213	332	310	457	306	268	285	
				Standard Deviation in Percent						
All samples	23	23	13	17	24	50	23	30	25	
Sub-berm	15	8	9	18	23	52	19	20	20	
Mean (sub-berm)	4	3	2	6	5	14	6	6	6	

Table 4 (continued)

Profile K - 1049 feet South of Profile G

Time

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1957	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
					Phi Units					
0-3	1.79	-	-	-	1.54	2.17	1.83	1.95	1.86	276
3-6	2.06	2.20	2.26	1.67	1.99	1.80	1.24	1.73	1.87	273
6-9	1.88	2.19	2.34	2.11	2.03	1.39	1.16	1.77	1.86	275
9-12	1.33	1.69	1.97	1.98	2.13	1.48	1.26	1.63	1.69	310
12-15	1.73	-	-	1.71	1.62	1.40	1.56	1.67	1.62	325
15 +	1.96	-	-	1.87	1.96	-	1.41	1.54	1.75	297
					Averages					
All samples	1.65	2.00	2.18	1.91	1.90	1.73	1.40	1.73	1.81	285
Sub-berm	1.59	2.00	2.30	1.96	1.91	1.83	1.28	1.80	1.83	281
					Standard Division					
All samples	.158	.285	.263	.209	.261	.365	.217	.235	.249	-
Sub-berm	.548	.285	.095	.211	.228	.357	.347	.243	.289	-
Mean (sub-berm)	.152	.090	.032	.070	.063	.120	.131	.070	.091	-
					Number of Samples					
All samples	17	10	12	14	18	12	12	17	112	-
Sub-berm	13	10	9	9	13	9	7	12	82	-
					Averages in Microns					
All samples	319	250	221	266	268	301	379	301	285	-
Sub-berm	332	250	203	257	266	281	412	287	281	-
					Standard Deviation in Percent					
All samples	12	22	20	16	20	29	16	18	19	-
Sub-berm	46	22	7	16	17	28	27	18	22	-
Mean (Sub-berm)	11	6	2	5	5	9	10	5	7	-

Table 4 (continued)

Profile L - Approximately 2.5 miles South of Profile K

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
					Phi Units					
0-3	-	-	-	-	1.72	2.06	-	1.44	1.74	299
3-6	-	1.98	2.20	0.84	1.93	1.89	1.51	1.45	1.69	310
6-9	1.31	1.84	2.22	1.38	1.43	1.56	1.73	1.61	1.64	321
9-12	1.56	1.69	1.84	1.38	1.64	1.56	1.96	1.62	1.66	316
12-15	1.46	1.47	1.31	1.56	1.87	1.57	1.77	1.71	1.59	332
15 +	1.58	1.50	-	1.55	-	-	1.84	1.63	1.62	325
					Averages					
All samples	1.50	1.69	1.96	1.43	1.68	1.78	1.79	1.60	1.68	312
Sub-berm	1.44	1.73	1.99	1.33	1.61	1.84	1.76	1.55	1.66	316
					Standard Deviation					
All samples	.200	.249	.367	.210	.298	.314	.198	.111	.243	--
Sub-berm	.221	.254	.296	.227	.313	.250	.214	.112	.246	--
Mean (sub-berm)	.074	.073	.079	.072	.090	.095	.068	.040	.074	--
					Number of Samples					
All samples	14	14	16	18	16	9	19	13	119	--
Sub-berm	9	12	14	10	12	7	10	8	82	--
					Averages in Microns					
All samples	354	310	257	371	312	291	289	330	312	--
Sub-berm	368	301	352	398	328	279	295	341.	316	--
					Standard Deviation in Percent					
All samples	15	19	29	16	23	24	15	8	18	
Sub-berm	17	19	23	17	24	19	16	8	19	
Mean (Sub-berm)	5	5	6	5	6	7	5	3	5	

Table 4 (continued)

Profile M - 252 feet South of Profile L

Elevation zones (feet)	J 27 July	L 14 Aug	N 13 Sept	P 10 Nov	R 28 Dec	T 9 Feb	V 10 Apr	X 6 June	Mean	Mean (microns)
					Time					
					Phi Units					
0-3	-	-	-	-	1.93	1.42	1.98	-	1.78	291
3-6	1.42	1.98	2.09	0.73	1.78	2.09	2.09	1.66	1.73	301
6-9	0.92	1.84	2.12	1.30	1.20	1.71	1.76	1.87	1.59	332
9-12	1.30	1.68	1.65	1.50	1.51	1.73	1.90	1.90	1.65	319
12-15	1.17	-	-	1.52	1.55	1.58	1.51	1.53	1.48	358
15 +	1.73	-	-	1.67	-	-	1.76	1.65	1.70	308
					Averages					
All samples	1.30	1.81	1.90	1.40	1.62	1.74	1.82	1.73	1.66	316
Sub-berm	1.15	1.81	1.99	1.36	1.64	1.79	1.91	1.78	1.68	312
					Standard Deviation					
All samples	.292	.123	.300	.234	.307	.229	.222	.151	.232	-
Sub-berm	.360	.123	.276	.216	.108	.215	.155	.173	.203	-
Mean (sub-berm)	.127	.050	.092	.060	.034	.065	.049	.052	.066	-
					Number of Samples					
All samples	11	6	11	15	14	13	17	15	102	-
Sub-berm	8	6	9	13	10	11	10	11	78	-
					Averages in Microns					
All samples	406	285	268	379	325	299	283	301	316	
Sub-berm	451	285	252	390	321	289	266	291	312	
					Standard Deviation in Percent					
All samples	22	9	23	17	24	17	17	11	17	
Sub-berm	28	9	21	16	8	16	11	13	15	
Mean(Sub-berm)	9	4	7	4	2	5	3	4	5	

Table 4 (continued)

Profile F - Sharps Park, 6.8 Miles South of Profile M

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
					Time / Phi Units					
0-3	-	-	-	-	1.72	1.48	-	1.47	1.56	339
3-6	-	1.59	-	-	1.87	1.53	1.00	1.16	1.43	371
6-9	1.56	1.81	1.45	1.58	1.81	2.03	1.20	0.04	1.44	369
9-12	1.72	1.73	1.63	2.01	1.96	2.12	0.97	1.00	1.64	321
12-15	1.65	1.60	1.75	1.89	2.07	--	1.36	0.83	1.59	332
15 +	1.89	--	--	1.75	--	--	1.98	--	1.87	273
					Averages					
All samples	1.71	1.66	1.65	1.84	1.85	1.83	1.28	0.94	1.60	330
Sub-berm	1.67	1.72	1.61	1.83	1.85	1.83	1.02	1.07	1.58	334
					Standard Deviation					
All samples	.125	.524	.210	.254	.153	.306	.436	.399	.301	--
Sub-berm	.111	.169	.248	.264	.153	.306	.231	.146	.204	--
Mean (sub-berm	.064	.053	.102	.118	.046	.082	.087	.055	.076	--
					Number of Samples					
All samples	5	15	10	8	11	14	11	12	86	--
Sub-berm	3	10	6	5	11	14	7	7	63	--
					Averages in Microns					
All samples	306	316	319	279	277	281	412	521	330	
Sub-berm	314	304	328	281	277	281	493	476	334	
					Standard Deviation in Percent					
All samples	9	44	16	19	11	24	35	32	23	
Sub-berm	8	12	19	20	11	24	17	11	15	
Mean (sub-berm	5	4	7	9	3	6	6	4	5	

Table 4 (continued)

Profile E - 456 feet South of Profile F

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
	Phi Units									
0-3	-	-	-	-	1.82	1.72	-	-	1.77	293
3-6	-	1.32	-	1.53	1.76	1.70	0.04	1.15	1.25	420
6-9	1.43	-0.22	1.44	1.62	1.74	1.67	-	1.29	1.28	412
9-12	1.40	1.22	1.65	1.74	-	1.88	0.69	1.22	1.37	387
12-15	1.65	1.54	1.63	2.00	1.89	1.94	1.23	0.96	1.61	328
15 +	1.51	1.28	1.55	1.69	1.68	1.48	1.59	1.45	1.53	346
Averages										
All samples	1.49	1.14	1.57	1.73	1.76	1.75	0.99	1.30	1.47	361
Sub-berm	1.41	0.72	1.56	1.68	1.78	1.74	0.48	1.34	1.34	395
Standard Deviation										
All samples	.162	.862	.161	.161	.167	.132	.612	.283	.318	-
Sub-berm	.101	1.136	.117	.090	.122	.103	.476	.227	.296	-
Mean (sub-berm)	.034	.402	.052	.034	.038	.028	.195	.093	.109	-
Number of Samples										
All samples	16	19	14	13	18	16	13	14	123	-
Sub-berm	9	8	5	7	10	13	6	6	64	-
Averages in Microns										
All samples	356	454	337	301	295	297	503	406	361	
Sub-berm	376	607	339	312	291	299	717	395	395	
Standard Deviation in Percent										
All samples	12	82	12	12	12	10	53	21	25	
Sub-berm	7	120	8	6	9	7	39	17	23	
Mean (sub-berm	2	32	4	2	3	2	15	7	8	

Table 4 (continued)

Profile C - Rockaway Beach, 1.6 miles South of Profile E

	Time									
	I	L	N	P	R	T	V	X	Mean	Mean
Elevation zones (feet)	18 July 1956	14 Aug 1956	13 Sept 1956	10 Nov 1956	28 Dec 1956	9 Feb 1957	10 Apr 1957	6 June 1957		(microns)
Phi Units										
0-3	-	-	-	-	-	-	-	-	-	-
3-6	-	0.32	-	-	0.72	0.28	0.23	1.19	0.55	683
6-9	0.98	1.32	1.59	1.50	1.60	0.82	0.57	0.51	1.11	463
9-12	1.47	1.47	1.45	1.76	1.26	0.96	0.81	0.91	1.26	418
12-15	1.58	1.39	1.46	1.96	1.44	1.79	1.51	1.24	1.54	344
15 +	1.13	0.89	-	2.36	1.41	-	1.55	1.44'	1.46	363
Averages										
All samples	1.34	1.18	1.48	1.72	1.31	0.89	0.92	1.05	1.24	423
Sub-berm	1.31	1.11	1.50	1.50	1.16	0.62	0.62	0.92	1.09	470
Standard Deviation										
All samples	.371	.450	.248	.434	.255	.474	.465	.543	.405	-
Sub-berm	.441	.546	.276	.369	.312	.320	.254	.140	.332	-
Mean (Sub-berm)	.156	.207	.113	.156	.156	.121	.104	.057	.134	-
Number of Samples										
All samples	14	12	9	10	9	10	10	11	85	-
Sub-berm	8	7	6	6	4	7	6	6	50	-
Averages in Microns										
All samples	395	441	358	304	403	540	529	483	423	
Sub-berm	403	464	354	354	448	651	651	529	470	
Standard Deviation in Percent										
All samples	29	37	19	35	19	39	38	46	32	
Sub-berm	36	46	21	29	24	25	19	10	26	
Mean (Sub-berm)	11	15	8	11	11	9	8	4	10	

Table 4 (continued)

Profile D - 378 Feet South of Profile C

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean (microns)
	Time									
	Phi Units									
0-3	-	-	-	-	−0.26	-	-	-	−0.26	1197
3-6	-	1.42	-	-	1.39	0.31	0.68	1.05	0.97	511
6-9	1.42	1.80	1.67	1.57	1.38	0.40	0.32	1.18	1.22	429
9-12	1.53	1.27	1.86	1.69	1.45	0.68	1.36	1.33	1.40	379
12-15	1.07	1.22	1.56	2.19	0.90	1.00	1.36	0.96	1.28	412
15 +	-	-	-	1.67	-	-	-	-	1.67	314
	Averages									
All samples	1.37	1.47	1.70	1.71	0.92	0.56	1.01	1.12	1.23	426
Sub-berm	1.47	1.50	1.79	1.60	0.92	0.47	0.77	1.16	1.21	432
	Standard Deviation									
All samples	.212	.320	.189	.231	.984	.298	.337	.158	.341	-
Sub-berm	.118	.326	.189	.098	.331	.199	.409	.154	.228	-
Mean Sub-berm)	.053	.109	.109	.049	.125	.089	.236	.069	.105	-
	Number of Samples									
All samples	8	10	5	6	8	6	5	6	54	-
Sub-berm	5	9	3	4	7	5	3	5	41	-
	Averages in Microns									
All samples	387	361	308	306	529	678	497	460	426	-
Sub-berm	361	354	289	330	529	722	586	448	432	-
	Standard Deviation in Percent									
All samples	16	25	14	17	88	23	26	12	27	
Sub-berm	9	25	14	7	26	15	33	11	17	
Mean (Sub-berm)	4	8	8	3	9	6	18	5	8	

Table 5

Average Median Diameter of Elevation Zones
Northern Beaches

Elevation[1] zones (feet)	Profile (see Table 1 for location)						
	AE	AO	AW	Q	P	O	N
	Phi Units						
0-3	1.27	0.97	1.42	2.47	2.28	2.24	2.39
3-6	0.70	0.59	0.39	2.34	2.35	2.27	2.38
6-9	1.03	0.61	0.68	2.36	2.27	2.21	2.10
9-12	0.97	0.67	0.80	2.39[2]	2.17	2.06	2.02
12-15	0.73	0.83	0.80	-	-	-	2.20
15 +	0.66	0.78	0.85	-	-	-	-
	Averages						
All samples	0.80	0.71	0.82	2.35	2.28	2.18	2.09
Sub-berm	0.84	0.65	0.78	2.36	2.32	2.24	2.20
	Standard Deviation						
All samples	.408	.449	.332	.177	.208	.201	.255
Sub-berm	.372	.419	.295	.132	.191	.187	.206
Mean (Sub-berm	.145	.114	.092	.045	.058	.058	.078
	Averages in Microns						
All samples	574	612	566	196	206	221	235
Sub-berm	559	637	582	195	200	212	218
	Standard Deviation in Percent						
All samples	33	37	26	13	15	15	19
Sub-berm	29	34	23	10	14	14	15
Mean (Sub-berm	11	8	7	3	4	4	6

(1) Above mean lower low water.
(2) Including samples on berm at elevation of 8 to 9 feet.

Table 5 (continued)

Average Median Diameters of Elevation Zones

Southern Beaches

Elevation zones (feet)	Profile J	I	H	G	K	L	M	F	E	C	D
	Phi Units										
0-3	1.84	1.92	1.85.	1.77	1.86	1.74	1.78	1.56	1.77	-	-0.26
3-6	1.72	1.34	1.77	1.77	1.87	1.69	1.73	1.43	1.25	0.55	0.97
6-9	1.90	1.85	1.84	1.79	1.86	1.64	1.59	1.44	1.28	1.11	1.22
9-12	-	1.77	1.89	1.81	1.69	1.66	1.65	1.64	1.37	1.26	1.40
12-15	-	1.89	1.62	1.60	1.62	1.59	1.48	1.59	1.61	1.54	1.28
15 +	-	-	1.74	1.77	1.75	1.62	1.70	1.87	1.53	1.46	1.67
	Averages										
All samples	1.88	1.76	1.79	1.77	1.81	1.68	1.66	1.60	1.47	1.24	1.23
Sub-berm	1.88	1.77	1.86	1.81	1.83	1.66	1.68	1.58	1.34	1.09	1.21
	Standard Deviation										
All samples	.284	.417	.312	.320	.249	.243	.232	.301	.318	.405	.341
Sub-berm	.284	.418	.247	.260	.289	.246	.203	.204	.296	.332	.228
Mean (Sub-berm	.120	.127	.074	.080	.091	.074	.066	.076	.109	.134	.105
	Average in Microns										
All samples	272	295	289	293	285	312	316	330	361	423	426
Sub-berm	272	293	275	285	281	316	312	334	395	470	432
	Standard Deviation in Percent										
All samples	22	34	24	25	19	18	17	23	25	32	27
Sub-berm	22	34	19	20	22	19	15	15	23	26	17
Mean (Sub-berm)	9	9	5	6	7	5	5	5	8	10	8

Table 6

Average Median Diameter at Different Times on Northern Beaches

Profile	K	M	O	Q	S	U	W	Mean	Mean (microns)
	2 Aug 1956	15 Aug 1956	13 Oct 1956	27 Dec 1956	15 Jan 1957	13 Feb 1957	13 Apr 1957		
				Phi Units Sub-berm Samples					
AE	-	0.77	1.28	0.60	-	1.16	0.40	0.84	559
AO	-	0.23	1.35	0.42	0.58	1.15	0.19	0.65	637
AW	-	0.52	1.32	0.64	-	1.15	0.25	0.78	582
Q	2.27	2.40	2.53	2.38	-	-	2.24	2.36	195
P	2.38	2.20	2.37	2.44	-	2.45	2.05	2.32	200
O	2.20	2.18	2.38	2.39	-	2.20	2.06	2.24	212
N	2.34	2.34	2.37	2.50	-	1.92	1.73	2.20	218
				All Samples					
AE	-	0.73	1.23	0.61	-	0.95	0.48	0.80	574
AO	-	0.34	1.14	0.67	0.68	1.05	0.40	0.71	611
AW	-	0.60	1.13	0.75	-	1.15	0.49	0.82	566
Q	2.28	2.36	2.46	2.34	-	-	2.31	2.35	196
P	2.35	2.28	2.31	2.39	-	2.31	2.05	2.28	206
O	2.20	2.13	2.26	2.37	-	2.19	1.95	2.18	221
N	2.14	2.19	2.16	2.31	-	2.02	1.75	2.09	235

Table 6 (continued)

Variations in Median Diameter of Sub-berm Samples on Southern Beaches

Profile	I 19 July 1956	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Mean microns
					Phi Units Sub-berm						
J	-	2.19	-	2.39	2.05	1.49	2.12	1.01	1.91	1.88	272
I	-	2.25	2.15	1.98	1.71	1.74	1.39	1.51	1.43	1.77	293
H	-	2.12	2.24	2.26	1.92	1.18	1.73	1.75	1.68	1.86	275
G	-	2.06	2.20	2.23	1.59	1.69	1.13	1.71	1.90	1.81	285
K	-	1.59	2.00	2.30	1.96	1.91	1.83	1.28	1.80	1.83	281
L	-	1.44	1.73	1.99	1.33	1.61	1.84	1.76	1.55	1.66	316
M	-	1.15	1.81	1.99	1.36	1.64	1.79	1.91	1.78	1.68	312
F	1.67	-	1.72	1.61	1.83	1.85	1.83	1.02	1.07	1.58	334
E	1.41	-	0.72	1.56	1.68	1.78	1.74	0.48	1.34	1.34	395
C	1.31	-	1.11	1.50	1.50	1.16	0.62	0.62	0.92	1.09	470
D	1.47	-	1.50	1.79	1.60	0.92	0.47	0.77	1.16	1.21	432
					All Samples on Profile Line						
J	-	2.19	-	2.39	2.05	1.49	2.12	1.01	1.91	1.88	272
I	-	2.21	2.10	1.99	1.71	1.74	1.39	1.51	1.43	1.76	295
H	-	1.96	2.04	2.28	1.68	1.35	1.75	1.61	1.62	1.79	289
G	-	1.89	2.06	2.19	1.66	1.73	1.31	1.56	1.75	1.77	293
K	-	1.65	2.00	2.18	1.91	1.90	1.73	1.40	1.73	1.81	285
L	-	1.50	1.69	1.96	1.43	1.68	1.78	1.79	1.60	1.68	312
M	-	1.30	1.81	1.90	1.40	1.62	1.74	1.82	1.73	1.66	316
F	1.71	-	1.66	1.65	1.84	1.85	1.83	1.28	0.94	1.60	330
E	1.49	-	1.14	1.57	1.73	1.76	1.75	0.99	1.30	1.47	361
C	1.34	-	1.18	1.48	1.72	1.31	0.89	0.92	1.05	1.24	423
D	1.37	-	1.47	1.70	1.71	0.92	0.56	1.01	1.12	1.23	426

Table 7

Variations in Sorting Coefficients of Elevation Zones on Northern Beaches

Profile AE - Pt. Reyes Beach (East)
(See Table 1 for location of Profiles)

Elevation (1) zones (feet)	M 15 Aug 1956	O 13 Oct 1056	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean
			Time			
3-6	1.21	1.15	1.31	1.24	1.26	1.23
6-9	1.29	1.16	1.29	1.33	1.32	1.28
9-12	1.25	1.21	1.33	1.29	1.27	1.27
12-15	-	1.25	1.31	1.67	1.29	1.38
15 +	1.31	1.32	1.37	1.34	1.33	1.33
			Averages			
All samples	1.28	1.23	1.34	1.34	1.31	1.30
Sub-berm	1.26	1.22	1.31	1.34	1.27	1.28
			Standard Deviation			
All samples	.068	.271	.083	.123	.068	.123
Sub-berm	.057	.080	.057	.153	.032	.076
Mean (Sub-berm)	.017	.019	.016	.058	.012	.024
			Beach Position			
Berm elevation (feet)	15.9	15.9	16.3	16.1	17.2	16.3
10 ft. contour(2)	46	57	128	105	143	96

(1) Above mean lower low water.
(2) Distance in feet from O station to 10 foot contour.

Table 7 (continued)

Variations in Sorting Coefficients in Elevation Zones on Northern Beaches

Profile AO - Pt. Reyes Beach (center)
(See Table 1 for location of profiles)

Elevation zones (feet)	M 15 Aug	O 13 Oct	Q 27 Dec	S 15 Jan	U 13 Feb	W 13 Apr	Mean
			Time				
0-3	-	-	-	1.23	1.21	-	1.22
3-6	1.28	1.39	-	1.19	1.27	1.21	1.27
6-9	1.29	1.32	1.25	1.32	1.49	1.26	1.32
9-12	1.22	1.22	1.34	1.25	1.49	1.27	1.30
12-15	1.30	1.28	1.33	1.29	1.42	1.27	1.32
15 +	1.33	1.29	1.34	1.33	1.33	1.32	1.32
			Averages				
All samples	1.30	1.28	1.33	1.27	1.35	1.29	1.30
Sub-berm	1.28	1.27	1.32	1.24	1.36	1.26	1.29
			Standard Deviation				
All samples	.069	.072	.064	.077	.131	.068	.080
Sub-berm	.069	.078	.046	.075	.167	.064	.083
Mean (Sub-berm)	.018	.021	.015	.020	.048	.016	.023
			Beach Position				
Berm elevation (feet)	16.5	16.5	-	-	15.5	18.5	16.8
10-foot contour(1)	30	55	95	120	108	60	78

(1) Distance in feet from O Station to 10-foot contour

Table 7 (continued)

Profile AW - Pt. Reyes Beach (West)
(See Table 1 for location of profiles)

Elevation zones (feet)	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean
			Time			
0-3	-	-	-	1.26	-	-
3-6	1.27	1.21	-	1.23	1.34	1.26
6-9	1.25	1.22	1.30	-	1.29	1.27
9-12	1.28	1.19	1.30	1.55	1.27	1.32
12-15	1.35	1.22	1.25	1.40	1.30	1.31
15 +	1.28	1.33	1.26	1.30	1.33	1.30
		Averages				
All samples	1.28	1.25	1.27	1.35	1.32	1.29
Sub-berm	1.28	1.23	1.27	1.38	1.33	1.30
		Standard Deviation				
All samples	.053	.021	.072	.140	.095	.076
Sub-berm	.059	.050	.090	.465	.109	.155
Mean (Sub-berm)	.017	.014	.028	.155	.041	.051
		Beach Position				
Berm elevation (feet)	16.7	16.6	18.0	-	18.2	17.2
10 foot contour (1)	63	55	30	90	68	61

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile Q - Drakes Cove
(See Table 1 for location of profiles)

Elevation zones (feet)	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	W 13 Apr 1957	Mean
			Time			
0-3	-	1.13	1.15	1.13	-	1.14
3-6	1.20	1.17	1.12	1.20	1.11	1.16
6-9	1.23	1.21	1.15	1.25	1.23	1.21
9-12(1)	1.18	1.20	1.16	1.20	1.20	1.19
			Averages			
All samples	1.20	1.18	1.15	1.19	1.19	1.18
Sub-berm	1.22	1.18	1.14	1.18	1.19	1.18
			Standard Deviation			
All samples	.064	.047	.019	.057	.069	.051
Sub-berm	.051	.052	.033	.060	.073	.054
Mean (Sub-berm)	.016	.016	.012	.017	.028	.018
			Beach Position			
Berm elevation (feet)	8.9	7.3	9.1	9.0	7.3	8.3
6 foot contour(2)	244	256	229	210	130	214

(1) Includes samples on berm at elevation of 8 to 9 feet.
(2) Distance in feet from O Station to 6 foot contour.

Table 7 (continued)

Profile P - Stinson Beach (West)
(See Table 1 for location of profiles)

Elevation zones (feet)	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec. 1956	U 13 Feb 1957	W 13 Apr 1957	Mean
			Time				
0-3	-	-	1.51	1.27	1.27	1.39	1.36
3-6	1.34	1.35	1.14	1.21	1.13	1.32	1.25
6-9	1.17	1.15	1.25	1.22	1.19	1.19	1.19
9-12	1.37	-	1.17	1.17	1.25	1.20	1.23
			Averages				
All samples	1.29	1.26	1.24	1.22	1.21	1.33	1.26
Sub-berm	1.30	1.31	1.27	1.24	1.19	1.36	1.28
			Standard Deviation				
All samples	.147	.117	.174	.075	.094	.110	.143
Sub-berm	.156	.102	.188	.083	.112	.337	.196
Mean (Sub-berm)	.040	.034	.062	.025	.037	.097	.059
			Beach Position				
Basin elevation (feet)	6.8	7.5	7.0	8.0	7.5	none	7.4
6 foot contour(1)	200	209	193	147	154	143	174

(1) Distance in feet from O Station to 6 foot contour

Table 7 (continued)

Profile O - Stinson Beach (Center)
(See Table 1 for Location of profiles)

Elevation zones (feet)	Time						
	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean
0-3	1.46	-	-	1.37	1.35	1.03	1.30
3-6	1.34	1.41	1.34	1.14	1.28	1.22	1.29
6-9	1.16	1.35	1.19	1.14	1.22	1.27	1.22
9-12	1.24	1.28	1.26	1.18	1.18	1.19	1.22
Averages							
All samples	1.27	1.34	1.25	1.19	1.27	1.20	1.25
Sub-berm	1.27	1.37	1.24	1.19	1.28	1.21	1.26
Standard Deviation							
All samples	.110	.101	.065	.093	.078	.089	.089
Sub-berm	.110	.098	.073	.105	.075	.103	.094
Mean (Sub-berm)	.028	.030	.024	.028	.025	.036	.028
Beach Position							
Berm elevation (feet)	8.0	8.0	7.7	10.0	none	9.5	8.6
6 foot contour(1)	154	173	181	137	127	127	150

(1) Distance in feet from O Station to 6 foot contour

Table 7 (continued)

Profile N - Stinson Beach (East)
(See Table 1 for location of profiles)

Elevation zones (feet)	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean
			Time				
0-3	-	-	-	1.20	-	-	-
3-6	1.22	1.34	1.16	1.14	1.42	1.19	1.25
6-9	1.17	1.20	1.15	1.12	1.31	1.39	1.22
9-12	1.24	1.22	1.25	1.22	1.21	1.24	1.23
12-15	1.20	-	-	1.22	1.18	1.18	1.20
			Averages				
All samples	1.22	1.23	1.23	1.19	1.29	1.26	1.24
Sub-berm	1.20	1.23	1.18	1.15	1.35	1.29	1.23
			Standard Deviation				
All samples	.184	.081	.055	.146	.140	.104	.118
Sub-berm	.058	.098	.056	.036	.132	.128	.085
Mean (Sub-berm)	.021	.028	.025	.011	.040	.048	.029
			Beach Position				
Berm elevation (feet)	9.3	none	9.4	10.8	9.5	9.0	9.6
8 foot contour(1)	328	343	368	315	302	326	330

(1) Distance in feet from O Station to 8 foot contour.

Table 7 (continued)

Profile J - Ocean Beach

(See Table 1 for location of profiles)

Time

Elevation zones (feet)	J 27 July 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
0-3	-	-	1.20	1.33	1.16	1.30	1.33	1.26
3-6	1.23	1.16	1.19	1.52	1.22	3.14	1.25	1.53
6-9	1.21	1.14	-	-	1.22	1.58	1.25	1.28
Averages								
All samples	1.22	1.16	1.19	1.36	1.19	2.01	1.27	1.34
Sub-berm	1.22	1.16	1.19	1.36	1.19	2.01	1.27	1.34
Standard Deviation								
All samples	.078	.011	.022	.168	.070	.810	.058	.174
Sub-berm	.078	.011	.022	.168	.070	.810	.058	.174
Mean (Sub-berm	.011	.006	.017	.069	.023	.468	.016	.087
Beach Position								
Berm elevation (feet)	none	none	none	none	none	none	none	none
5 foot contour(1)	40	46	29	40	55	29	74	45

(1) Distance from O Station to 5 foot contour

Table 7 (continued)

Profile I - Ocean Beach

(See Table 1 for location of profiles)

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
				Time					
0-3	-	-	-	1.25	1.29	1.17	1.26	1.25	1.24
3-6	1.16	1.14	1.31	1.96	1.72	1.48	2.24	1.44	1.56
6-9	1.19	1.20	1.20	1.34	1.35	1.32	1.23	1.20	1.25
9-12	1.21	1.28	1.26	1.28	1.23	1.29	1.19	1.14	1.24
12-15	1.25	1.29	1.24	1.30	-	-	1.34	-	1.28
				Averages					
All samples	1.19	1.21	1.24	1.46	1.36	1.32	1.52	1.29	1.32
Sub-berm	1.18	1.20	1.25	1.46	1.36	1.32	1.52	1.29	1.32
				Standard Deviation					
All samples	.042	.067	.066	.370	.211	.127	.464	.112	.182
Sub-berm	.033	.062	.072	.370	.211	.127	.464	.112	.181
Mean (Sub-berm	.010	.022	.023	.131	.064	.037	.140	.031	.057
				Beach Position					
Berm elevation	12.0	11.5	12.0	11.5	none	none	none	none	11.8
10 foot contour(1)	37	35	35	35	28	37	30	37	34

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile H - Ocean Beach

(See Table 1 for location of profiles)

	Time								
Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X- 6 June 1957	Mean
0-3	-	-	-	--	1.42	1.33	1.30	1.36	1.35
3-6	1.21	1.29	1.17	1.23	1.40	1.27	1.30	1.31	1.27
6-9	1.21	1.19	1.18	1.39	1.27	1.23	1.29	1.26	1.25
9-12	1.25	1.28	1.24	1.25	1.25	1.21	1.17	1.26	1.24
12-15	1.24	1.29	-	1.35	1.29	1.29	1.54	1.26	1.32
15 +	1.23	-	-	-	1.25	-	1.29	1.25	1.26
	Averages								
All samples	1.23	1.25	1.19	1.33	1.35	1.27	1.32	1.28	1.28
Sub-berm	1.23	1.22	1.19	1.32	1.37	1.26	1.28	1.30	1.27
	Standard Deviation								
All samples	.026	.061	.044	.091	.161	.045	.152	.049	.079
Sub-berm	.030	.041	.046	.095	.055	.047	.081	.047	.055
Mean (Sub-berm	.009	.016	.014	.032	.014	.018	.027	.014	.018
	Beach Position								
Berm elevation (feet)	11.1	10.8	11.0	11.1	none	11.3	none	none	11.1
10 foot contour(1)	122	115	115	105	85	89	100	115	106

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile G - Ocean Beach

(See Table 1 for location of profiles)

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov. 1956	R 28 Dec. 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
				Time					
0-3	1.23	-	-	-	1.39	1.59	1.30	1.30	1.36
3-6	1.20	1.15	1.23	1.37	1.31	1.45	1.34	1.37	1.30
6-9	1.23	1.18	1.20	1.31	1.28	1.24	1.31	1.24	1.25
9-12	1.28	1.27	1.28	1.25	1.26	1.25	1.28	1.18	1.26
12-15	1.31	-	-	1.31	1.27	1.29	1.30	1.30	1.30
15 +	1.22	-	-	-	1.27	-	1.23	1.25	1.24
				Averages					
All samples	1.25	1.21	1.23	1.31	1.32	1.40	1.29	1.29	1.29
Sub-berm	1.24	1.20	1.22	1.33	1.33	1.44	1.31	1.30	1.30
				Standard Deviation					
All samples	.066	.062	.052	.172	.079	.213	.097	.062	.100
Sub-berm	.071	.059	.046	.053	.079	.236	.051	.159	.094
Mean (Sub-berm)	.022	.022	.031	.018	.019	.075	.017	.048	.032
				Beach Position					
Berm elevation (feet)	11.1	11.2	11.2	11.6	none	none	none	none	11.3
10 foot contour[1]	149	139	135	109	84	93	132	123	121

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile K - Ocean Beach

(See Table 1 for location of profiles)

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
				Time					
0-3	1.47	-	-	-	1.27	1.19	1.39	1.27	1.32
3-6	1.25	1.20	1.18	1.35	1.19	1.31	1.46	1.28	1.28
6-9	1.28	1.22	1.18	1.23	1.21	1.29	1.33	1.26	1.25
9-12	1.22	1.22	1.24	1.27	1.24	1.31	1.29	1.20	1.25
12-15	1.27	-	-	1.28	1.27	1.29	1.22	1.34	1.28
15 +	1.20	-	-	1.22	1.25	-	1.27	1.26	1.24
				Averages					
All samples	1.25	1.21	1.20	1.27	1.23	1.26	1.33	1.26	1.25
Sub-berm	1.25	1.21	1.18	1.27	1.22	1.25	1.38	1.27	1.25
				Standard Deviation					
All samples	.075	.039	.040	.054	.041	.078	.101	.044	.059
Sub-berm	.087	.039	.020	.063	.039	.079	.103	.041	.059
Mean (Sub-berm	.024	.012	.007	.021	.017	.026	.039	.012	.020
				Beach Position					
Berm elevation (feet)	10.2	11.2	11.6	11.1	none	12.7	none	none	11.5
10 feet contour(1)	170	150	143	114	82	108	75	75	115

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile L - Ocean Beach

(See Table 1 for location of profiles)

Time

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
0-3	-	-	-	-	1.46	1.34	-	1.40	1.40
3-6	-	1.20	1.26	-	1.34	1.21	1.34	1.42	1.29
6-9	1.34	1.19	1.25	1.30	1.22	1.23	1.24	1.20	1.25
9-12	1.20	1.19	1.28	1.21	1.34	1.31	1.22	1.20	1.24
12-15	1.25	1.26	1.31	1.24	1.26	1.24	1.26	1.22	1.26
15 +	1.26	1.18	-	1.30	-	-	1.25	1.18	1.23
Averages									
All samples	1.25	1.22	1.27	1.27	1.28	1.26	1.26	1.25	1.26
Sub-berm	1.25	1.21	1.26	1.27	1.29	1.26	1.26	1.28	1.26
Standard Deviation									
All samples	.083	.041	.073	.056	.080	.093	.065	.038	.066
Sub-berm	.095	.040	.070	.061	.088	.104	.076	.109	.080
Mean sub-berm	.032	.015	.019	.019	.025	.039	.024	.038	.026
Beach Position									
Berm elevation (feet)	12.1	11.8	12.0	11.9	12.8	12.0	10.5	11.0	11.8
10 foot contour(1)	160	145	160	135	129	145	172	150	150

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile M - Ocean Beach

(See Table 1 for location of profiles)

Time

Elevation zones (feet)	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov. 1956	R 28 Dec. 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
0-3	-	-	-	-	1.39	1.35	1.29	-	1.34
3-6	1.22	1.24	1.22	1.39	1.38	1.24	1.30	1.23	1.28
6-9	1.29	1.21	1.22	1.32	1.38	1.26	1.28	1.22	1.27
9-12	1.27	1.25	1.23	1.21	1.22	1.31	1.25	1.22	1.25
12-15	1.27	-	-	1.26	1.22	1.25	1.22	1.26	1.25
15 +	1.26	-	-	1.23	-	-	1.27	1.24	1.25
Averages									
All samples	1.25	1.23	1.22	1.28	1.31	1.26	1.27	1.23	1.26
Sub-berm	1.24	1.23	1.22	1.27	1.35	1.27	1.26	1.23	1.26
Standard Deviation									
All samples	.128	.024	.035	.075	.109	.103	.047	.094	.077
Sub-berm	.149	.024	.037	.073	.105	.053	.052	.041	.067
Mean (Sub-berm)	.053	.010	.012	.020	.033	.016	.016	.012	.022
Beach Position									
Berm elevation (feet)	12.0	11.7	12.0	12.0	13.3	14.2	15.7	14.3	12.8
10 foot contour(1)	113	120	126	134	137	130	145	129	130

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile F - Sharp Park

(See Table 1 for location of profiles)

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
				Time					
0-3	-	-	-	-	1.20	1.21	-	-	1.21
3-6	-	1.17	-	-	1.16	1.20	1.34	1.36	1.25
6-9	1.16	1.15	1.30	1.22	1.12	1.16	1.26	1.66	1.25
9-12	1.21	1.21	1.18	1.22	1.17	1.21	1.43	1.37	1.25
12-15	1.14	1.19	1.20	1.28	1.22	-	1.30	1.38	1.24
15 +	1.19	-	-	1.22	-	-	1.27	-	1.23
				Averages					
All samples	1.18	1.19	1.22	1.22	1.17	1.19	1.33	1.39	1.24
Sub-berm	1.19	1.18	1.22	1.22	1.17	1.19	1.36	1.38	1.24
				Standard Deviation					
All samples	.025	.045	.061	.041	.041	.043	.155	.135	.068
Sub-berm	.025	.034	.076	.033	.041	.043	.102	.166	.065
Mean (Sub-berm)	.014	.018	.031	.015	.012	.016	.039	.063	.026
				Beach Position					
Berm elevation (feet)	12.3	12.0	12.7	13.0	none	14.0	none	13.5	12.9
10 foot contour(1)	143	151	135	110	102	85	112	155	124

(1) Distance in feet from O Station to 10 foot contour

Table 7 (continued)

Profile E - Sharp Park

(See Table 1 for location of profiles)

Time

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
0-3	-	-	-	-	1.17	1.21	-	-	1.19
3-6	-	1.37	-	1.27	1.17	1.15	1.82	1.35	1.36
6-9	1.19	1.42	1.37	1.24	1.20	1.17	-	1.18	1.25
9-12	1.31	1.38	1.23	1.20	-	1.17	1.54	1.22	1.30
12-15	1.27	1.35	1.21	1.25	1.14	1.28	1.36	1.19	1.26
15 +	1.40	1.51	1.56	1.32	1.33	1.52	1.32	1.32	1.41
Averages									
All samples	1.30	1.40	1.29	1.26	1.23	1.21	1.47	1.26	1.30
Sub-berm	1.28	1.39	1.28	1.22	1.16	1.18	1.63	1.25	1.30
Standard Deviation									
All samples	.127	.296	.136	.082	.121	.093	.339	.094	.161
Sub-berm	.122	.309	.082	.040	.035	.040	.192	.071	.111
Mean (Sub-berm)	.041	.109	.037	.015	.012	.011	.078	.029	.042
Beach Position									
Berm elevation (feet)	10.5	12.2	12.2	none	none	none	11.0	none	11.4
10 foot contour(1)	54	47	50	18	8	8	34	12	29

(1) Distance in feet from O station to 10 foot contour

Table 7 (continued)

Profile C - Rockaway Beach

(See Table 1 for location of profiles)

Time

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
3-6	-	1.58	-	-	1.41	1.60	1.52	1.40	1.50
6-9	1.37	1.44	1.38	1.33	1.19	1.25	1.45	1.47	1.36
9-12	1.28	1.22	1.31	1.21	1.28	1.25	1.32	1.37	1.28
12-15	1.28	1.24	1.29	1.25	1.23	1.24	1.29	1.19	1.25
15 +	1.30	1.31	-	1.32	1.35	-	1.36	1.19	1.31
				Averages					
All samples	1.30	1.33	1.33	1.31	1.28	1.35	1.37	1.32	1.32
Sub-berm	1.31	1.39	1.34	1.34	1.31	1.40	1.41	1.45	1.37
				Standard Deviation					
All samples	.100	.159	.058	.146	.077	.178	.090	.169	.122
Sub-berm	.129	.180	.055	.180	.081	.189	.082	.120	.127
Mean (Sub-berm)	.045	.068	.022	.074	.040	.072	.033	.049	.050
				Beach Position					
Berm elevation	none	10.9	12.1	16.8	none	none	none	11.4	12.8
10 foot contour(1)	87	106	93	98	96	90	75	75	90

(1) Distance in feet from O station to 10 foot contour

Table 7 (continued)

Profile D - Rockaway Beach

(See Table 1 for location of profiles)

Time

Elevation zones (feet)	I 19 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
0-3	-	-	-	-	1.55	-	-	-	-
3-6	-	1.26	-	-	1.32	1.64	1.46	1.33	1.40
6-9	1.31	1.18	1.25	1.26	1.25	1.28	1.31	1.12	1.25
9-12	1.30	1.39	1.35	1.30	1.27	1.43	1.26	1.21	1.31
12-15	1.31	1.30	1.26	1.29	1.26	1.40	1.27	1.33	1.30
15 +	-	-	-	1.24	-	-	-	-	-
Averages									
All samples	1.31	1.28	1.29	1.27	1.35	1.47	1.31	1.24	1.32
Sub-berm	1.32	1.28	1.31	1.27	1.36	1.48	1.35	1.22	1.32
Standard Deviation									
All samples	.074	.107	.189	.231	.984	.298	.337	.093	.289
Sub-berm	.085	.338	.101	.048	.141	.168	.079	.092	.132
Mean (Sub-berm	.038	.113	.059	.024	.053	.069	.045	.041	.055
Beach Position									
Berm elevation (feet)	none	none	13.0	none	none	none	none	none	13.0
10 foot contour(1)	43	50	63	50	35	38	40	27	43

(1) Distance in feet from O station to 10 foot contour

Table 8

Average Sorting Coefficients of Elevation Zones
Northern Beaches

Profile (see Table 1 for location of profiles)

Elevation[1] zones (feet)	AE	AO	AW	Q	P	O	N
				Sorting Coefficient			
0-3	-	1.22	1.26	1.14	1.36	1.30	1.26
3-6	1.23	1.27	1.26	1.16	1.25	1.29	1.25
6-9	1.28	1.32	1.27	1.21	1.19	1.22	1.22
9-12	1.27	1.30	1.32	1.19[2]	1.23	1.22	1.23
12-15	1.38	1.32	1.31	-	-	-	1.20
15 +	1.33	1.32	1.30	-	-	-	-
				Averages			
All samples	1.30	1.30	1.29	1.18	1.26	1.25	1.24
Sub-berm	1.28	1.29	1.29	1.18	1.28	1.26	1.23
				Standard Deviation			
All samples	.123	.080	.076	.051	.143	.089	.118
Sub-berm	.076	.083	.155	.054	.196	.094	.085
Mean (Sub-berm)	.024	.023	.051	.018	.059	.028	.029

(1) Above mean lower low water.
(2) Includes samples on berm at elevation of 8 to 9 feet.

Table 8 (continued)

Southern Beaches

Profile (see Table I for location of profiles)

Elevation zones (feet)	J	I	H	G	K	L	M	F	E	C	D
					Sorting Coefficient						
0-3	1.26	1.24	1.35	1.36	1.32	1.40	1.34	1.21	1.19	-	1.55
3-6	1.53	1.56	1.27	1.30	1.28	1.29	1.28	1.25	1.36	1.50	1.40
6-9	1.28	1.25	1.25	1.25	1.25	1.25	1.27	1.25	1.25	1.36	1.25
9-12	-	1.24	1.24	1.26	1.25	1.24	1.25	1.25	1.30	1.28	1.31
12-15	-	1.28	1.32	1.30	1.28	1.26	1.25	1.24	1.26	1.25	1.30
15 +	-	-	1.26	1.24	1.24	1.23	1.25	1.23	1.41	1.31	1.24
					Averages						
All samples	1.34	1.32	1.28	1.29	1.25	1.26	1.26	1.24	1.30	1.32	1.32
Sub-berm	1.34	1.32	1.27	1.30	1.25	1.26	1.26	1.24	1.30	1.37	1.32
					Standard Deviation						
All samples	.174	.182	.079	.100	.059	.066	.077	.068	.161	.122	.289
Sub-berm	.174	.181	.055	.094	.059	.080	.067	.065	.111	.127	.132
Mean (Sub-berm)	.087	.057	.018	.032	.020	.026	.022	.026	.042	.050	.055

Table 9

Average Sorting Coefficient at Different Times on Northern Beaches

Time

Profile	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	S 15 Jan 1957	U 13 Feb 1957	V 13 Apr 1957	Mean	Median
				Sorting Coefficient Sub-berm Samples					
AE	-	1.26	1.22	1.31	--	1.34	1.27	1.28	1.28
AO	-	1.28	1.27	1.32	1.24	1.36	1.26	1.29	1.28
AW	-	1.28	1.23	1.27	-	1.38	1.33	1.30	1.29
Q	1.22	1.18	1.14	1.18	-	-	1.19	1.18	1.18
P	1.30	1.31	1.27	1.24	-	1.19	1.36	1.28	1.28
O	1.27	1.37	1.24	1.19	-	1.28	1.21	1.26	1.26
N	1.20	1.23	1.18	1.15	-	1.35	1.29	1.23	1.23
				All Samples					
AE	-	1.28	1.23	1.34	-	1.34•	1.31	1.30	1.31
AO	-	1.30	1.28	1.33	1.27	1.35	1.29	1.30	1.30
AW	-	1.28	1.25	1.27	-	1.35	1.32	1.29	1.29
Q	1.20	1.18	1.15	1.19	-	-	1.19	1.18	1.19
P	1.29	1.26	1.24	1.22	-	1.21	1.33	1.26	1.26
O	1.27	1.34	1.25	1.19	-	1.27	1.20	1.25	1.25
N	1.22	1.23	1.23	1.19	-	1.29	1.26	1.24	1.23

Table 9 (continued)

Average Sorting Coefficient at Different Times on Southern Beaches

Pro-file	I 19 July 1956	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean	Me-dian
					Sorting Coefficient Sub-berm Samples						
J	-	1.22	-	1.16	1.19	1.36	1.19	2.01	1.27	1.34	1.25
I	-	1.18	1.20	1.25	1.46	1.36	1.32	1.52	1.29	1.32	1.31
H	-	1.23	1.22	1.19	1.32	1.37	1.26	1.28	1.30	1.27	1.27
G	-	1.24	1.20	1.22	1.33	1.33	1.44	1.31	1.30	1.30	1.31
K	-	1.25	1.21	1.18	1.27	1.22	1.25	1.38	1.27	1.25	1.26
L	-	1.25	1.21	1.26	1.27	1.29	1.26	1.26	1.28	1.26	1.26
M	-	1.24	1.23	1.22	1.27	1.35	1.27	1.26	1.23	1.26	1.25
F	1.19	-	1.18	1.22	1.22	1.17	1.19	1.36	1.38	1.24	1.21
E	1.28	-	1.39	1.28	1.22	1.18	1.18	1.63	1.25	1.30	1.27
C	1.31	-	1.39	1.34	1.34	1.31	1.40	1.41	1.45	1.37	1.37
D	1.32	-	1.28	1.31	1.27	1.36	1.48	1.35	1.22	1.32	1.32
Me-dian	1.30	1.24	1.23	1.22	1.27	1.33	1.36	1.36	1.28	1.30	1.27(1) 1.30(2)
					All Samples						
J	-	1.22	-	1.16	1.19	1.36	1.19	2.01	1.27	1.34	1.22
I	-	1.19	1.24	1.24	1.46	1.36	1.32	1.52	1.29	1.32	1.32
H	-	1.23	1.25	1.19	1.33	1.35	1.27	1.32	1.28	1.28	1.28
G	-	1.25	1.21	1.23	1.31	1.32	1.40	1.29	1.29	1.29	1.29
K	-	1.25	1.21	1.20	1.27	1.23	1.26	1.33	1.26	1.25	1.26
L	-	1.25	1.22	1.27	1.27	1.23	1.26	1.26	1.25	1.26	1.26
M	-	1.25	1.23	1.22	1.28	1.31	1.26	1.27	1.23	1.26	1.25
F	1.18	-	1.19	1.22	1.17	1.19	1.33	1.39	1.38	1.24	1.22
E	1.30	-	1.40	1.29	1.26	1.23	1.21	1.47	1.26	1.30	1.29
C	1.30	-	1.33	1.33	1.31	1.28	1.35	1.37	1.32	1.32	1.32
D	1.31	-	1.28	1.29	1.27	1.35	1.47	1.31	1.24	1.32	1.31
Me-dian	1.30	1.25	1.23	1.23	1.27	1.32	1.26	1.33	1.27	1.29	1.28(1) 1.27(2)

(1) Median of column
(2) Median of row

Table 10

Elevation[(1)] of berm at different times

Northern Beaches

Profile	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	U 13 Feb 1957	W 13 Apr 1957	Mean
AE	-	15.9	15.9	16.3	16.1	17.2	16.3
AO	-	16.5	16.5	-	15.5	18.5	16.8
AW	-	16.7	16.6	18.0	18.2	17.5	17.4
Q	8.9	7.3	9.1	9.0	-	7.3	8.3
P	6.8	7.5	7.0	8.0	7.5	none	7.4
O	8.0	8.0	7.7	10.0	none	9.5	8.6
N	9.3	none	9.4	10.8	9.5	9.0	9.6

Southern Beaches

Profile	I 19 July 1956	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov 1956	R 28 Dec 1957	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
					feet					
J	-	none	-	none	none	none	none	none	none	-
I	-	12.0	11.5	12.0	11.5	none	none	none	none	11.8
H	-	11.1	10.8	11.0	11.1	none	11.3	none	none	11.1
G	-	11.1	11.2	11.2	11.6	none	none	none	none	11.3
K	-	10.2	11.2	11.6	11.1	none	12.7	none	none	11.5
L	-	12.1	11.8	12.0	11.9	12.8	12.0	10.5	11.0	11.8
M	-	12.0	11.7	12.0	12.0	13.3	14.2	15.7	14.3	12.8
F	12.3	-	12.0	12.7	13.0	none	14.0	none	13.5	12.9
E	10.5	-	12.2	12.2	none	none	none	11.0	none	11.4
C	none	-	10.9	12.1	16.8	none	none	none	11.4	12.8
D	none	-	none	13.0	none	none	none	none	none	13.0

(1) Above mean lower low water.

Table 11

Advance and retreat of beaches

Northern Beaches

Profile	K 2 Aug 1956	M 15 Aug 1956	O 13 Oct 1956	Q 27 Dec 1956	S 15 Jan 1957	U 13 Feb 1957	W 13 Apr 1957	Mean
	Time							
Horizontal distance in feet of zero station from 10-foot contour.								
AE	-	46	57	128	-	105	143	96
AO	-	30	55	95	120	108	60	78
AW	-	63	55	30	-	90	68	61
$Q^{(1)}$	244	256	229	210	-	-	130	214
$P^{(1)}$	200	209	193	147	-	154	143	174
$O^{(1)}$	154	173	181	137	-	127	127	150
$N^{(2)}$	328	343	368	315	-	302	326	330

Southern Beaches

Profile	I 19 July 1956	J 27 July 1956	L 14 Aug 1956	N 13 Sept 1956	P 10 Nov. 1956	R 28 Dec 1956	T 9 Feb 1957	V 10 Apr 1957	X 6 June 1957	Mean
	Time									
					Feet					
$J^{(3)}$	-	40	-	46	29	40	55	29	74	45
I	-	37	35	35	35	28	37	30	37	34
H	-	122	115	115	105	85	89	100	115	106
G	-	149	139	135	109	84	93	132	123	121
K	-	170	150	143	114	82	108	75	75	115
L	-	160	145	160	135	129	145	172	150	150
M	-	113	120	128	134	137	130	145	129	130
F	143	-	151	135	110	102	85	112	155	124
E	54	-	47	50	18	8	8	34	12	29
C	87	-	106	93	98	96	90	75	75	90
D	43	-	50	63	50	35	38	40	27	43

(1) Distance from 6-foot contour
(2) Distance from 8-foot contour
(3) Distance from 5-foot contour

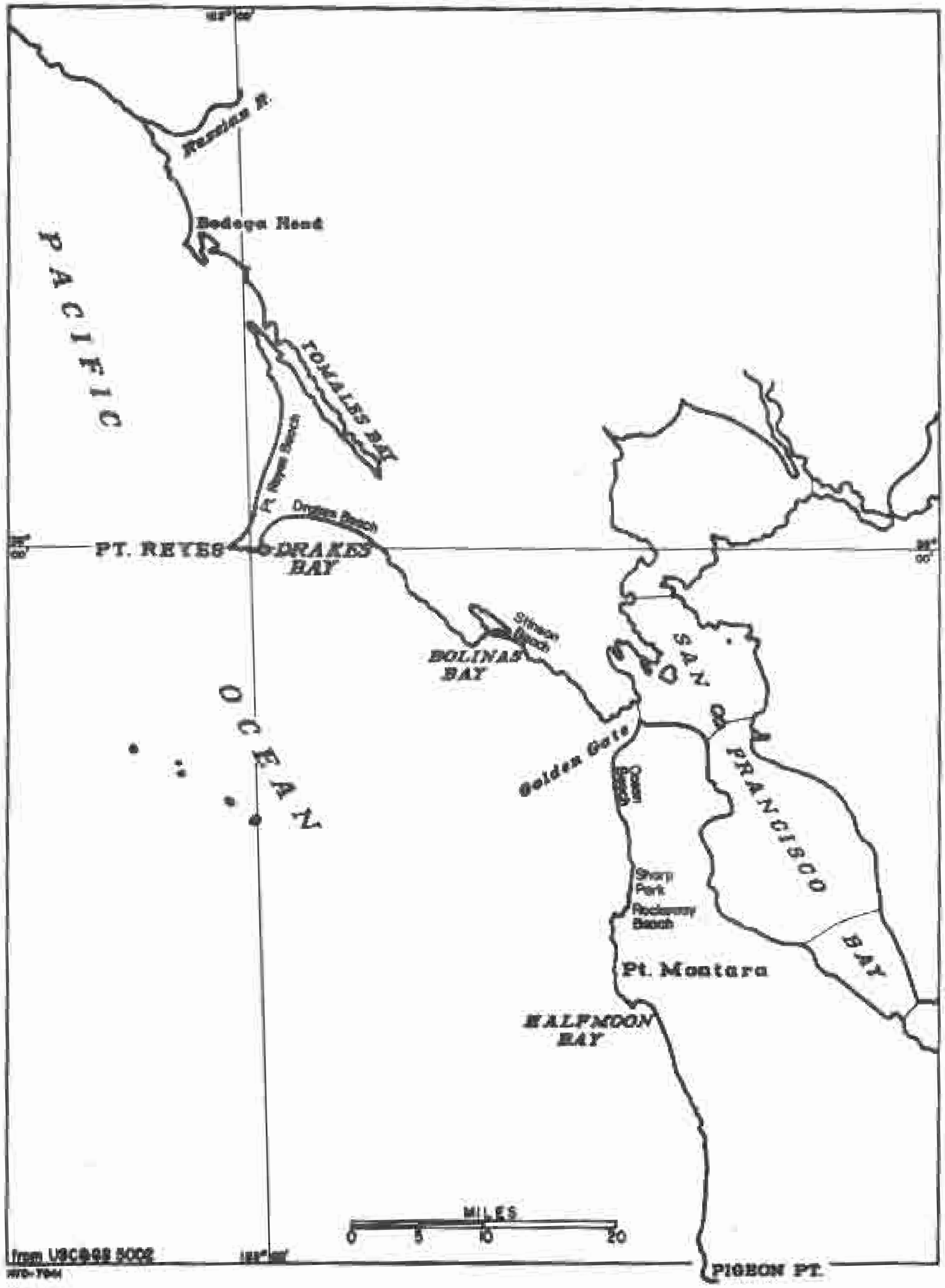

FIGURE I. LOCATION OF BEACHES

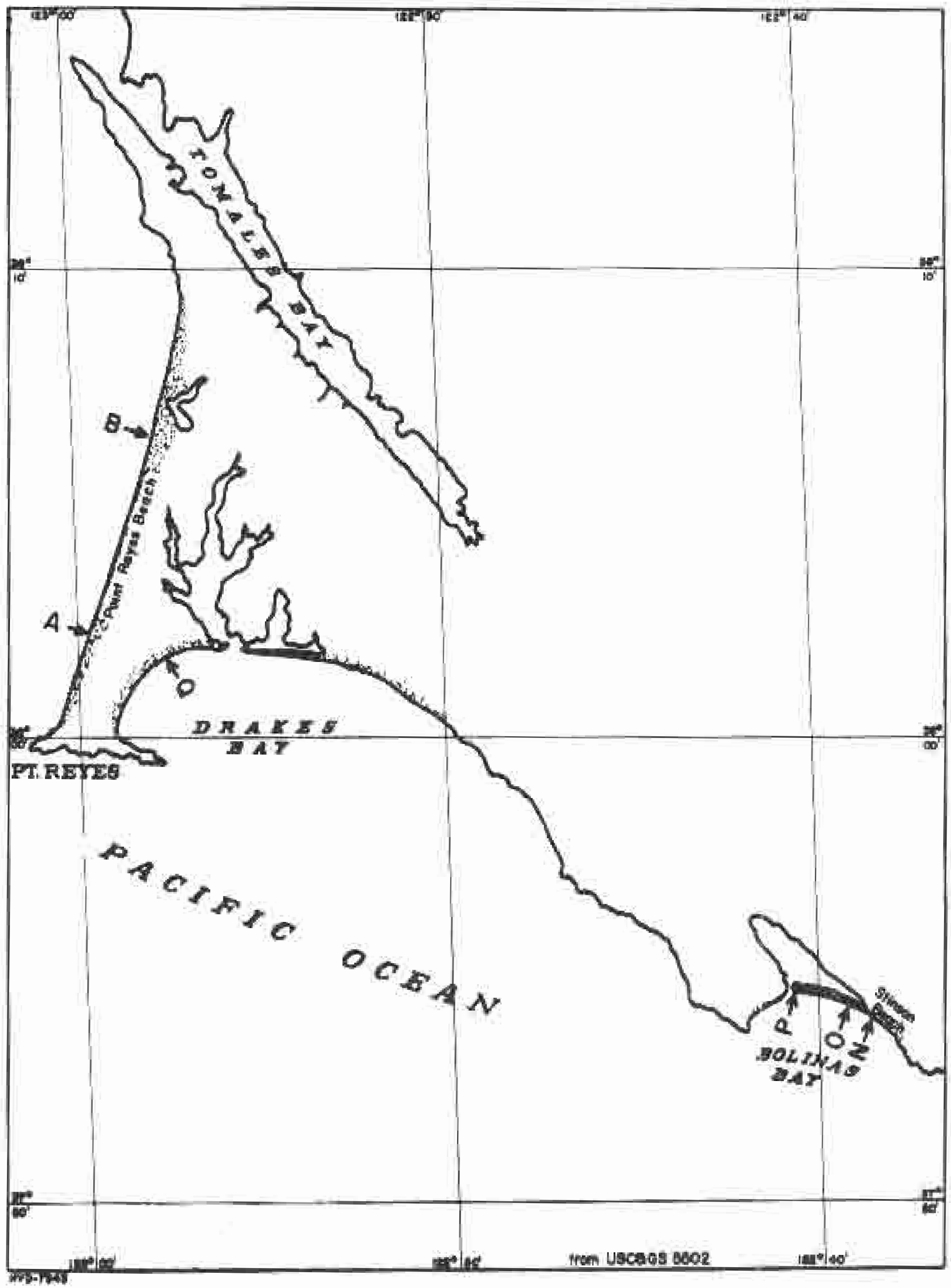

FIGURE 2. BEACHES NORTH OF GOLDEN GATE

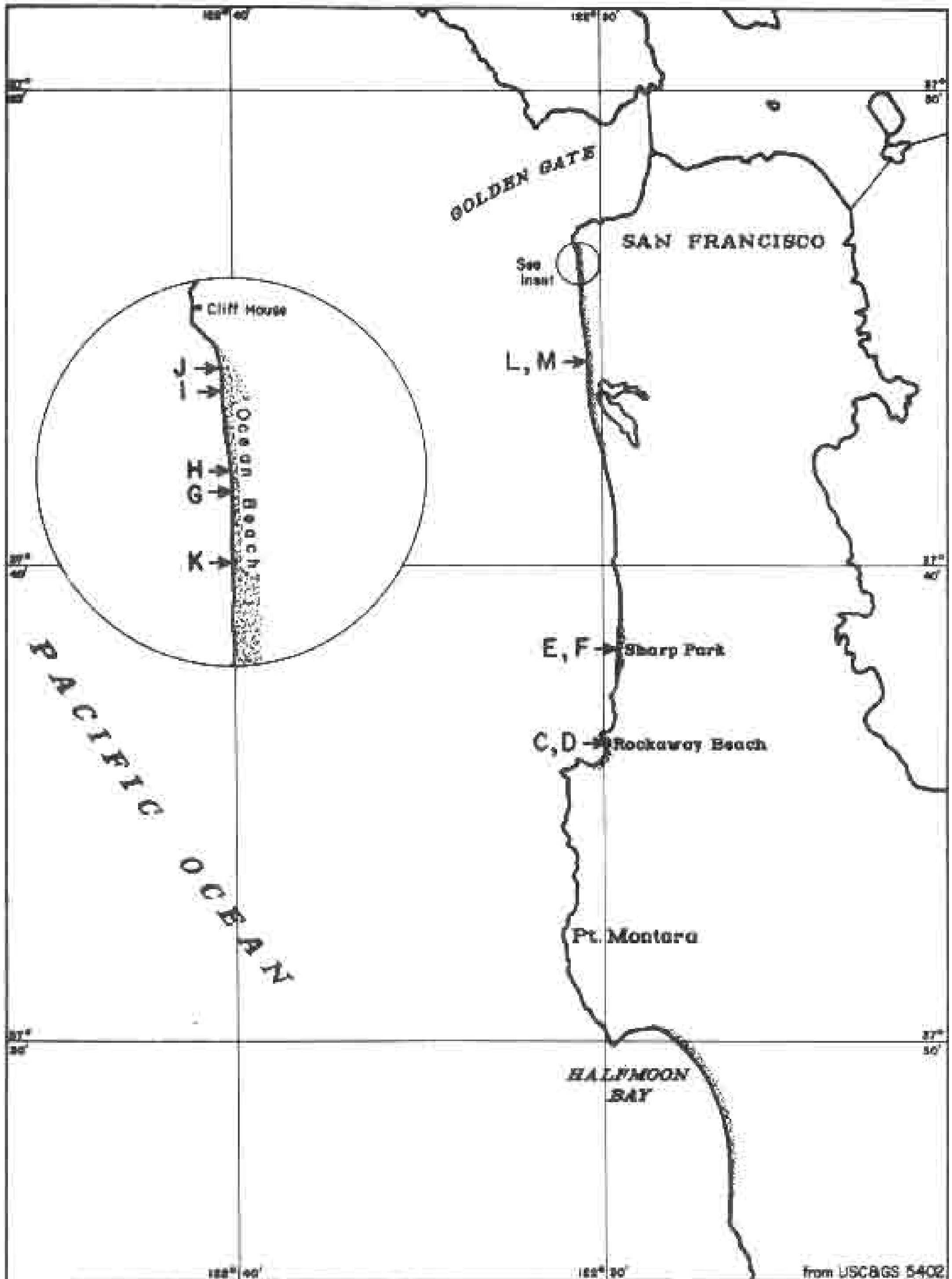

FIGURE 3. BEACHES SOUTH OF GOLDEN GATE

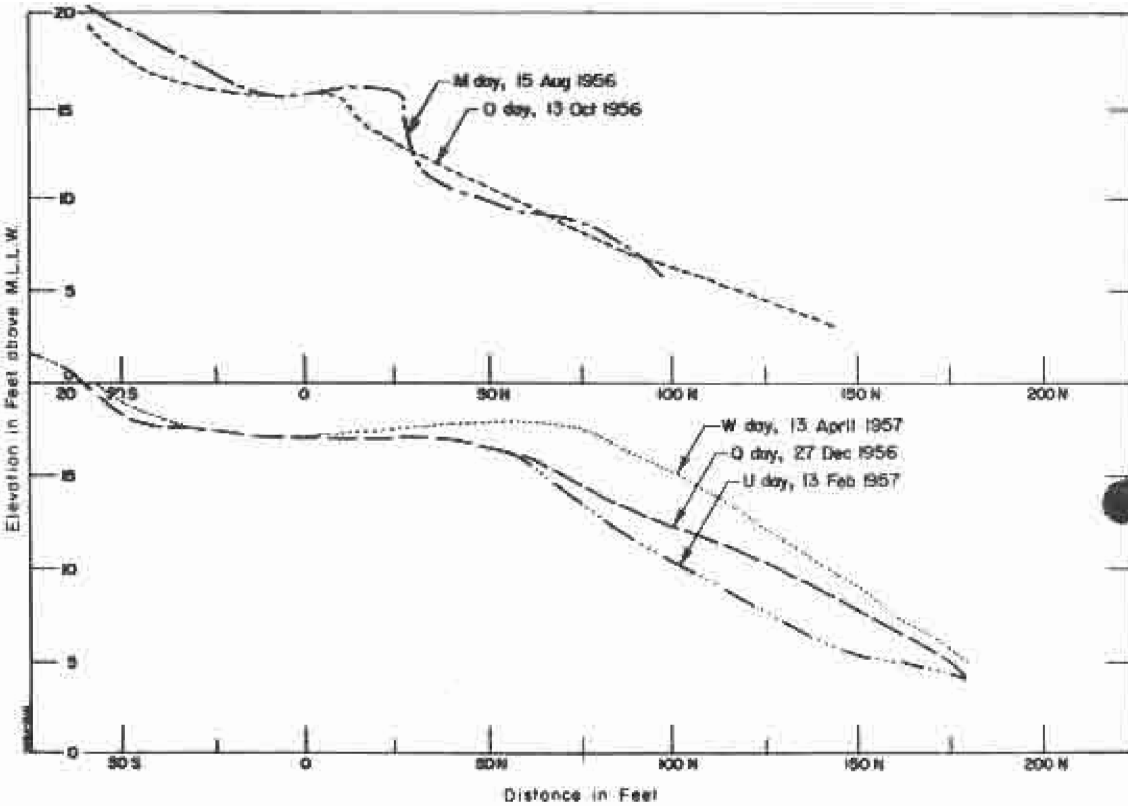

FIGURE 4. PROFILES ON LINE AE, PT. REYES, 1956-57

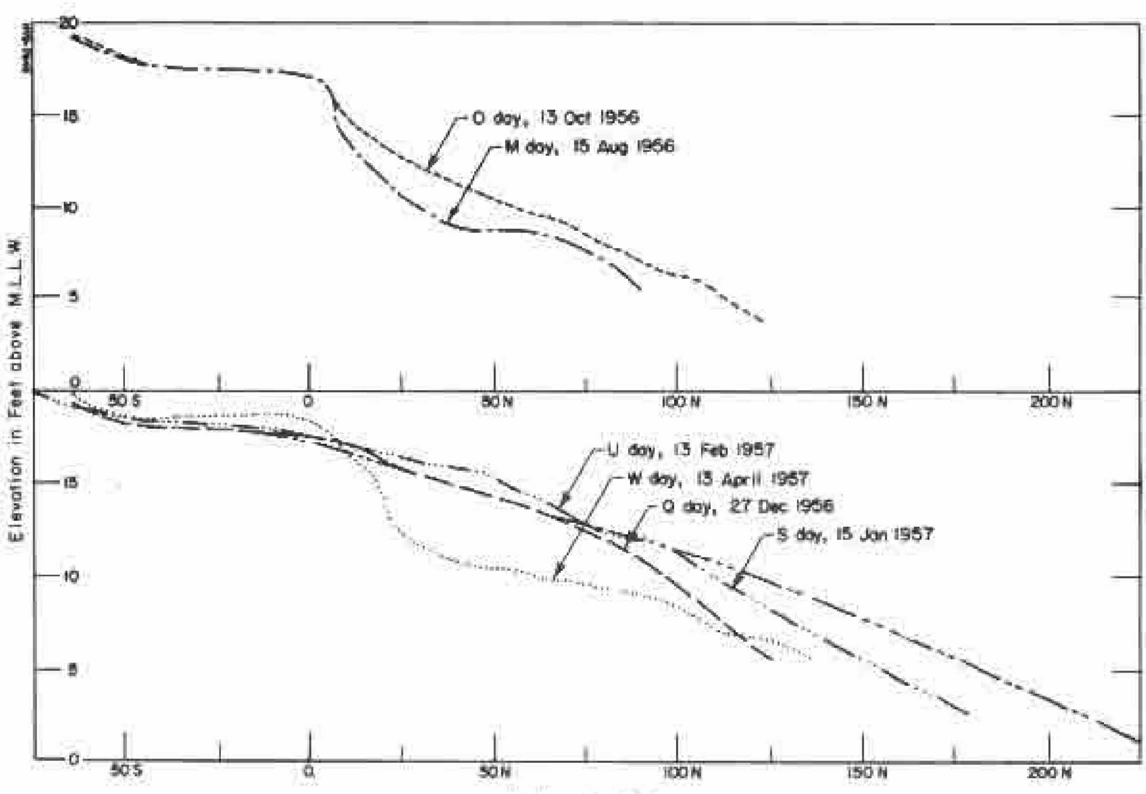

FIGURE 5. PROFILES ON LINE AO, PT. REYES, 1956-57

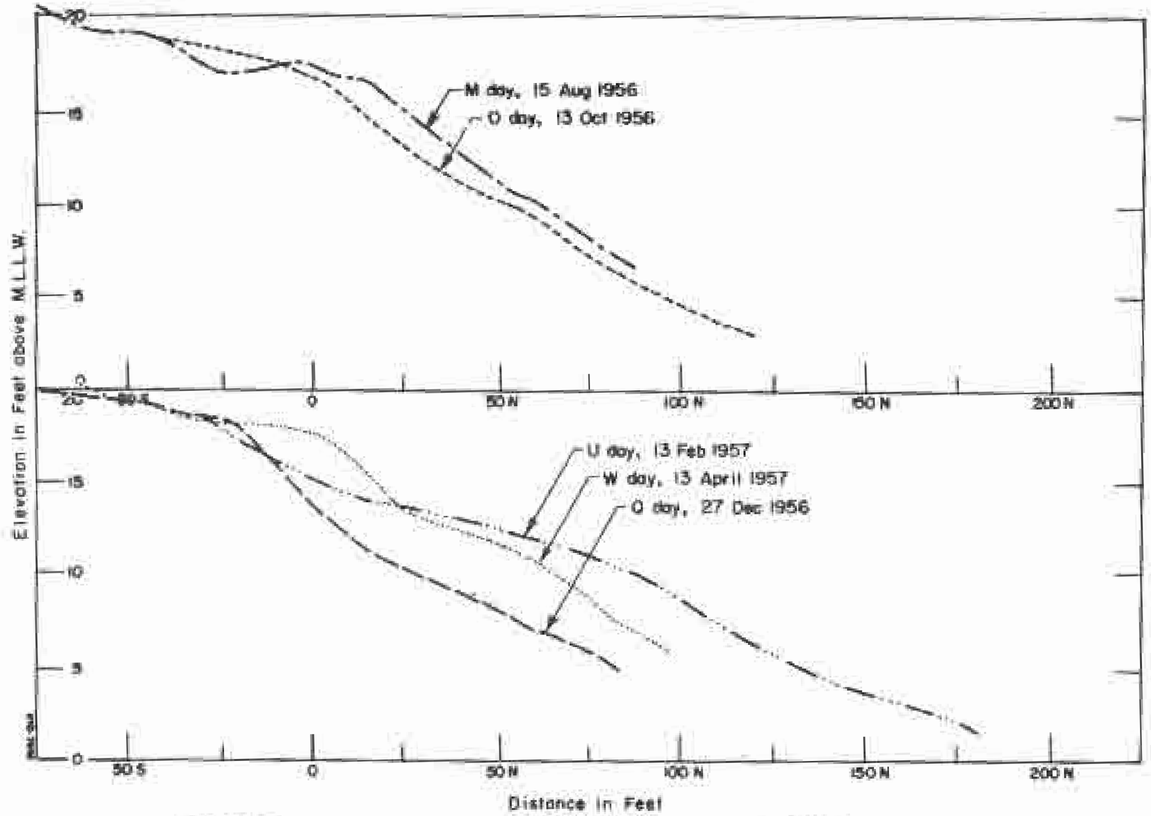

FIGURE 6. PROFILES ON LINE AW, PT. REYES, 1956-57

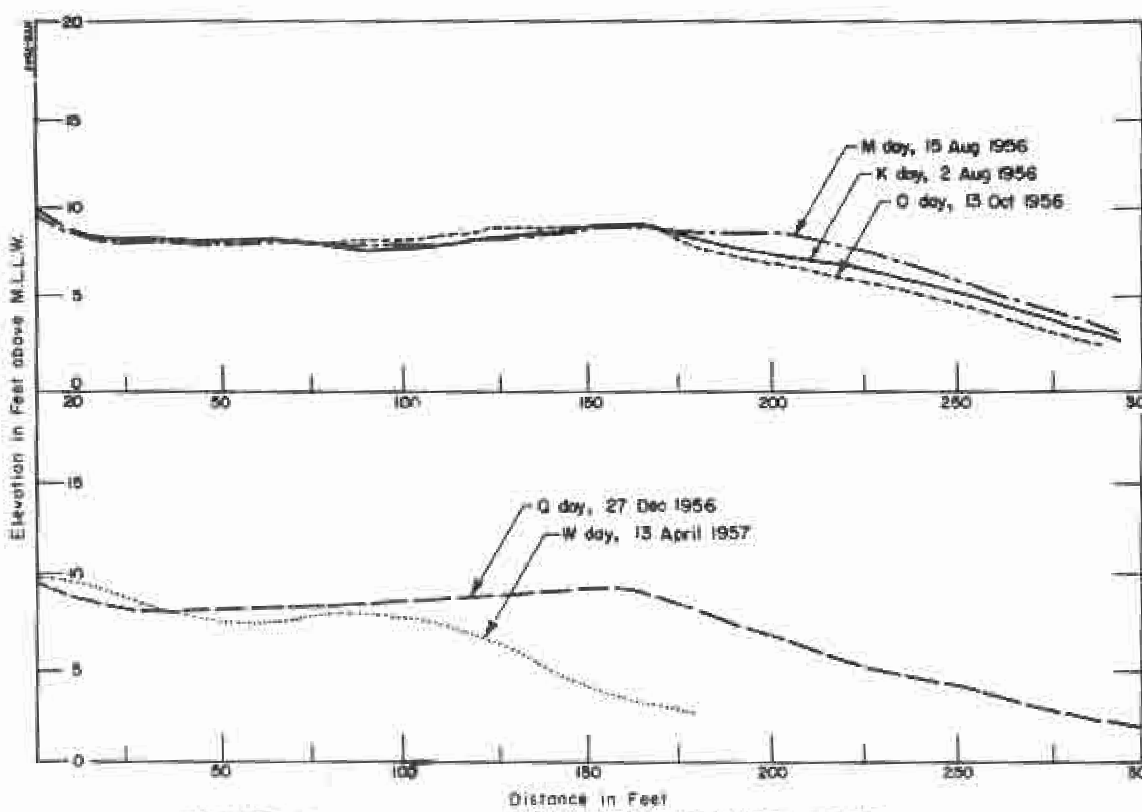

FIGURE 7. PROFILES ON LINE Q, DRAKES COVE, 1956-57

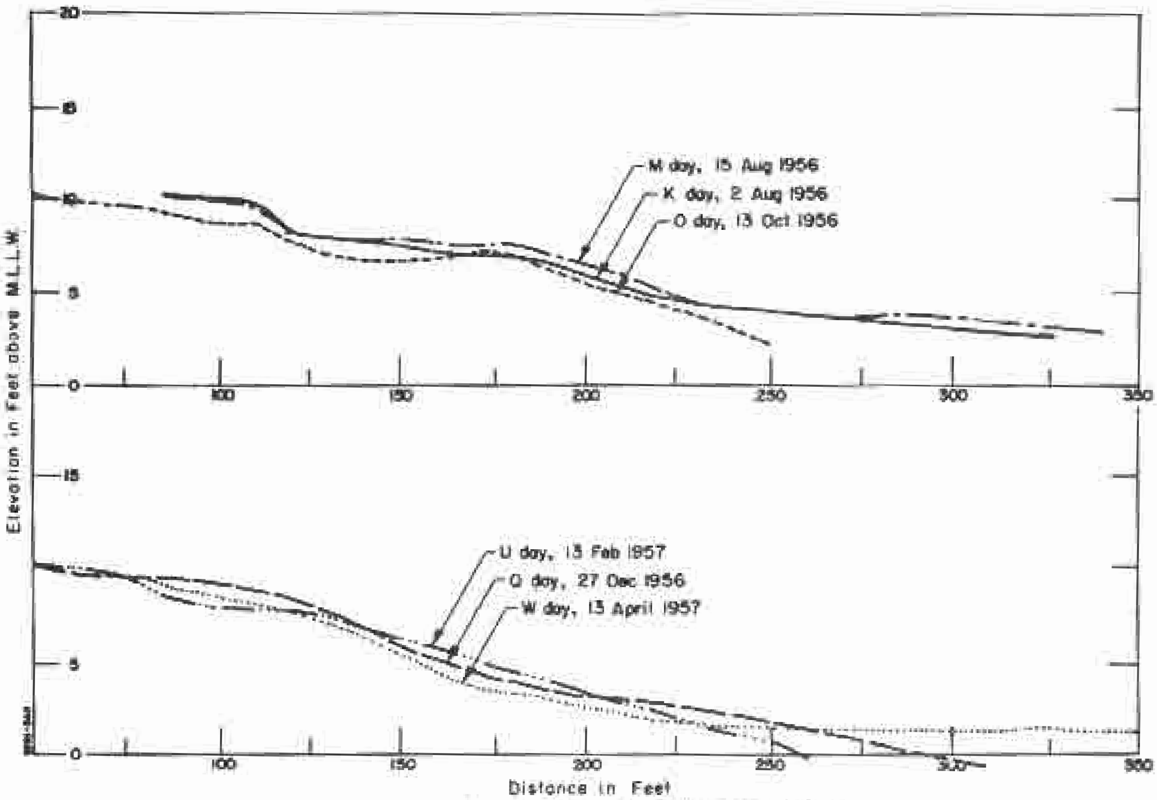

FIGURE 8. PROFILES ON LINE P, STINSON BEACH, 1956-57

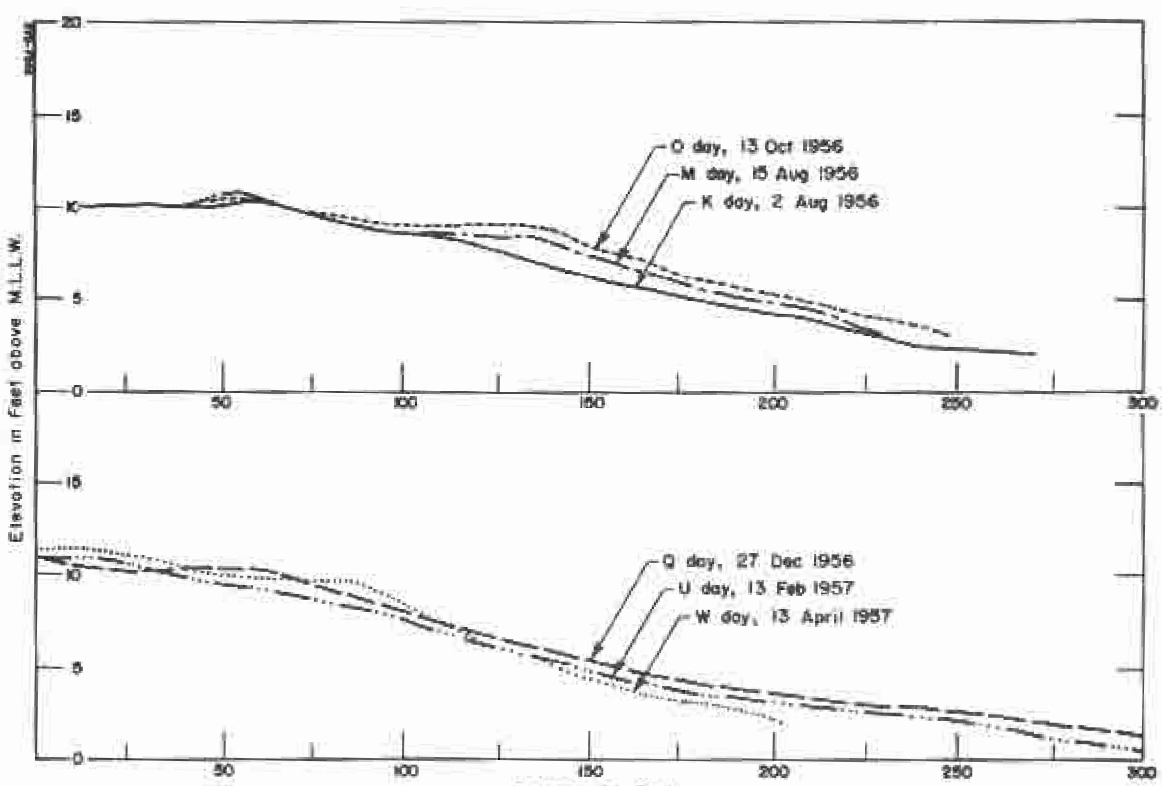

FIGURE 9. PROFILES ON LINE O, STINSON BEACH, 1956-57

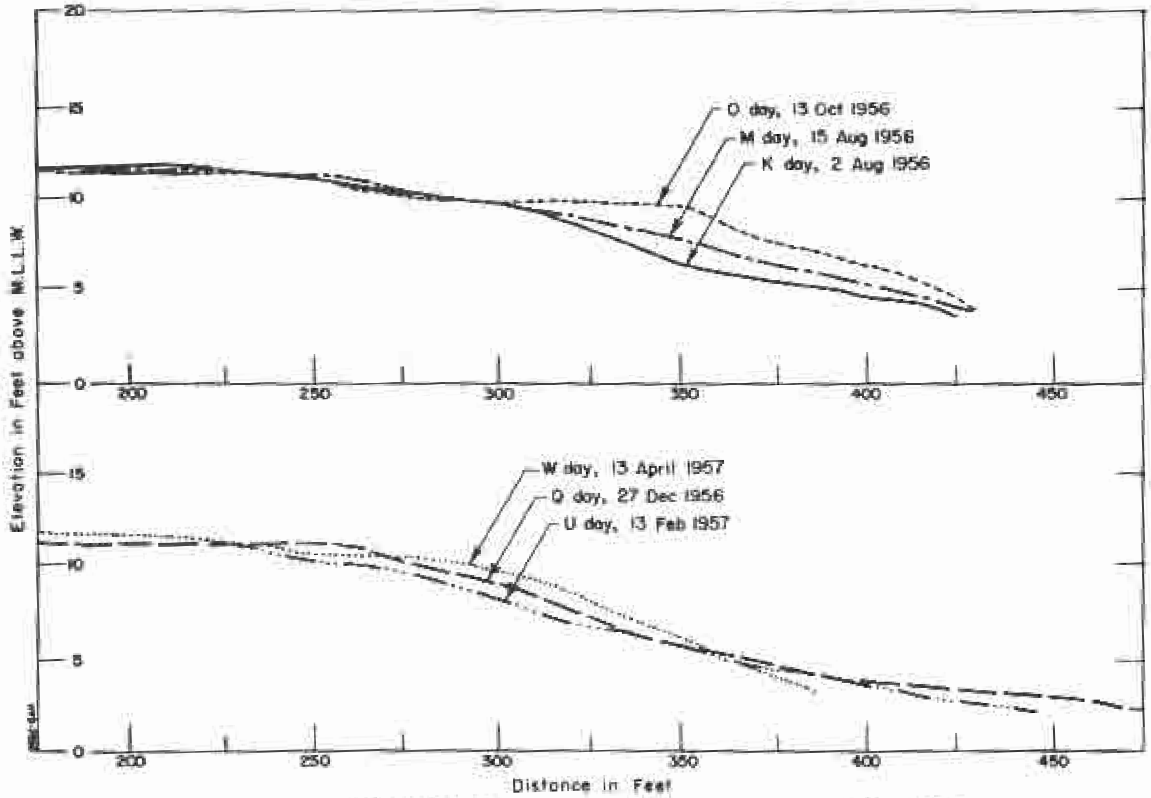

FIGURE 10. PROFILES ON LINE N, STINSON BEACH, 1956-57

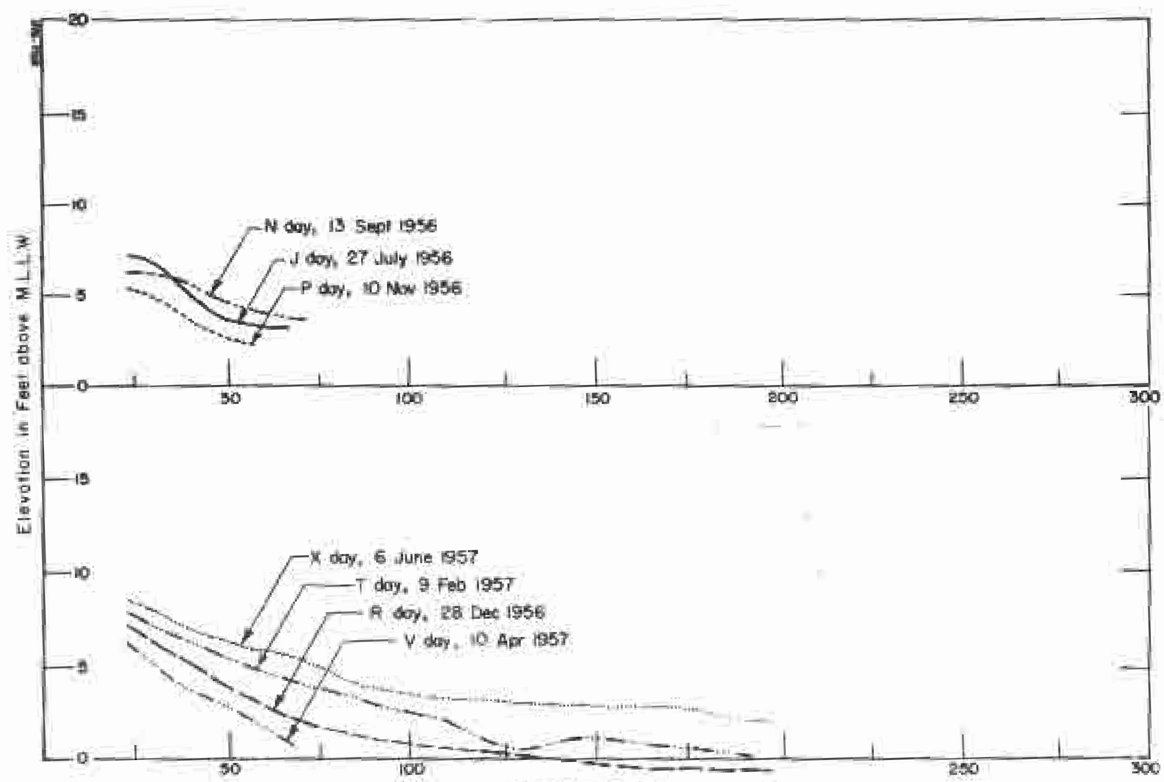

FIGURE 11. PROFILES ON LINE J, OCEAN BEACH, 1956-57

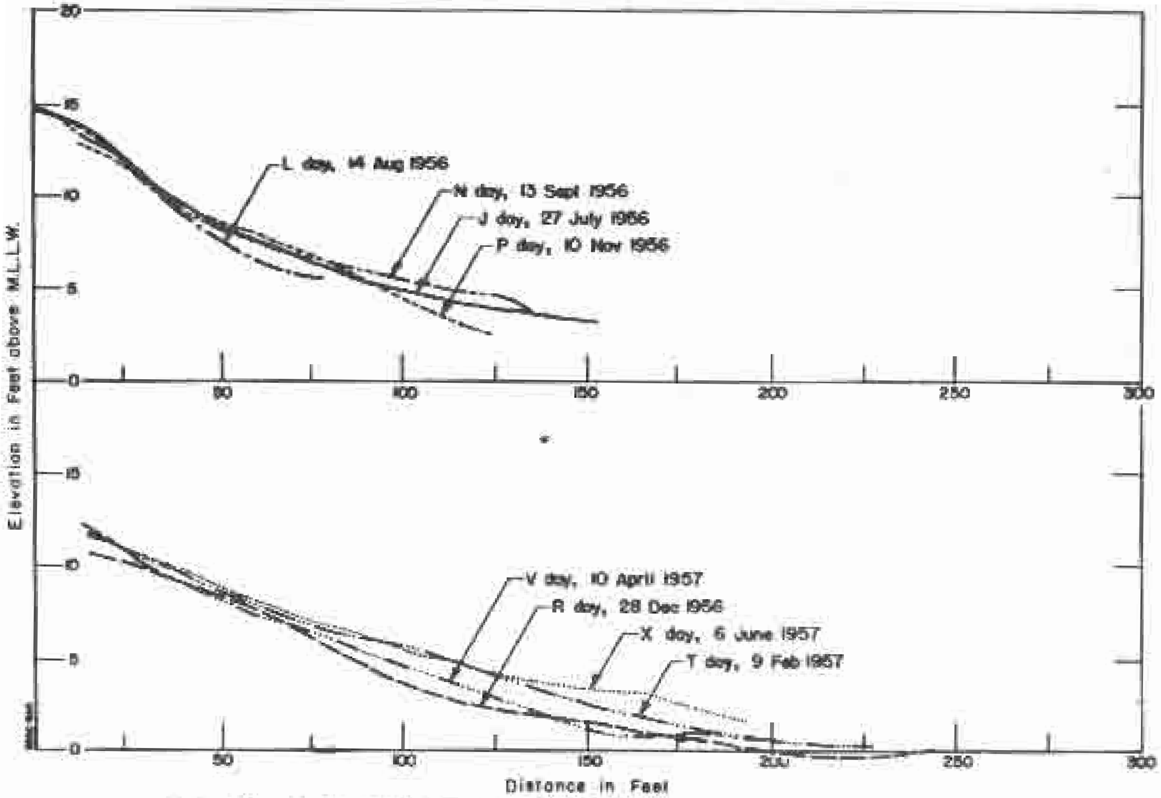

FIGURE 12. PROFILES ON LINE I, OCEAN BEACH, 1956-57

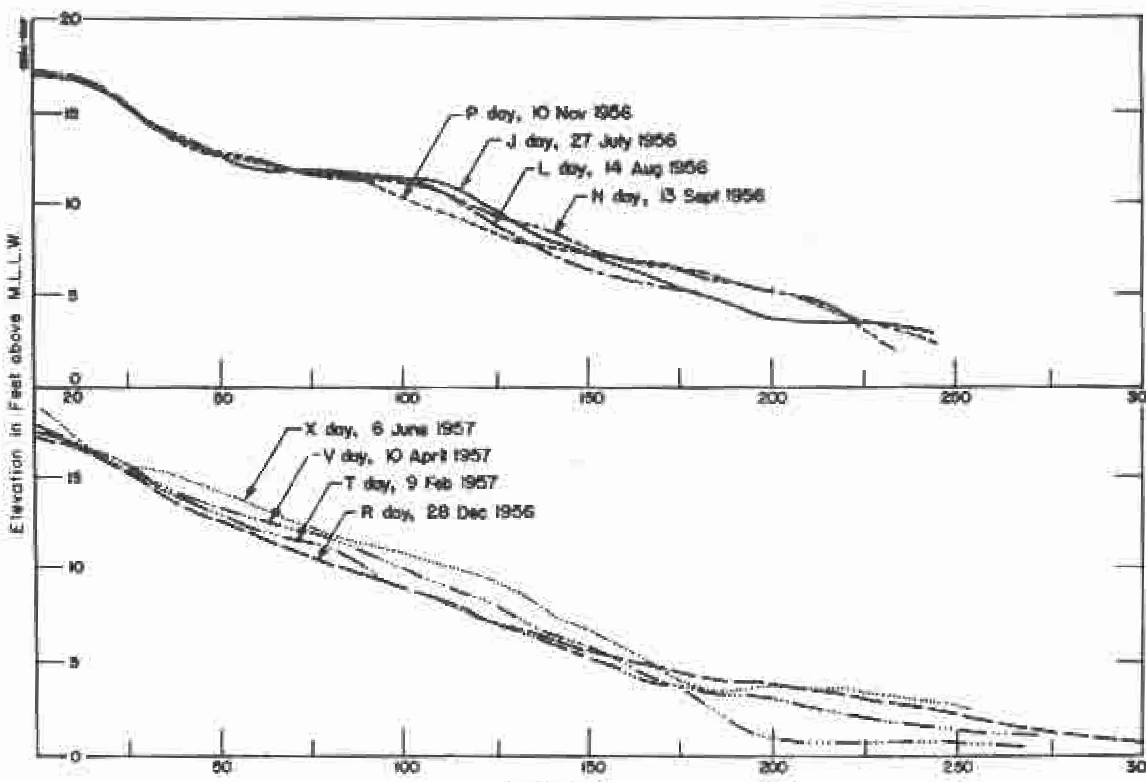

FIGURE 13. PROFILES ON LINE H, OCEAN BEACH, 1956-57

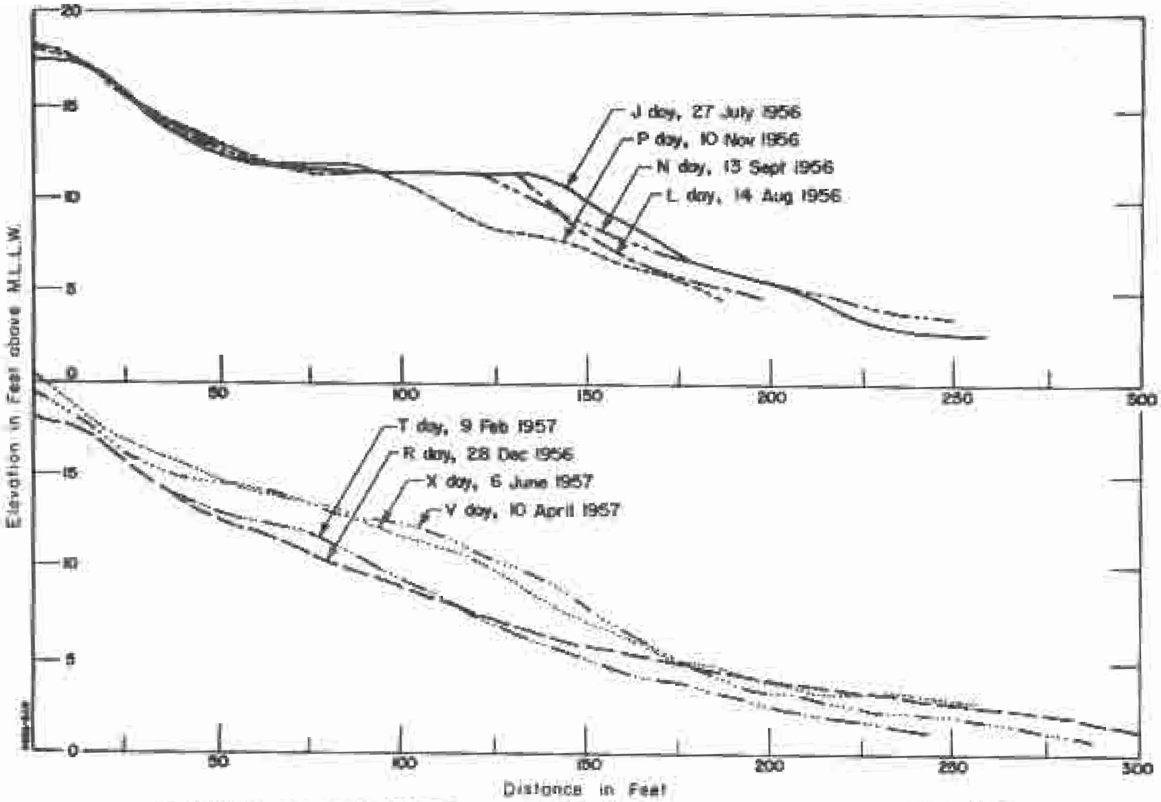

FIGURE 14. PROFILES ON LINE G, OCEAN BEACH, 1956-57

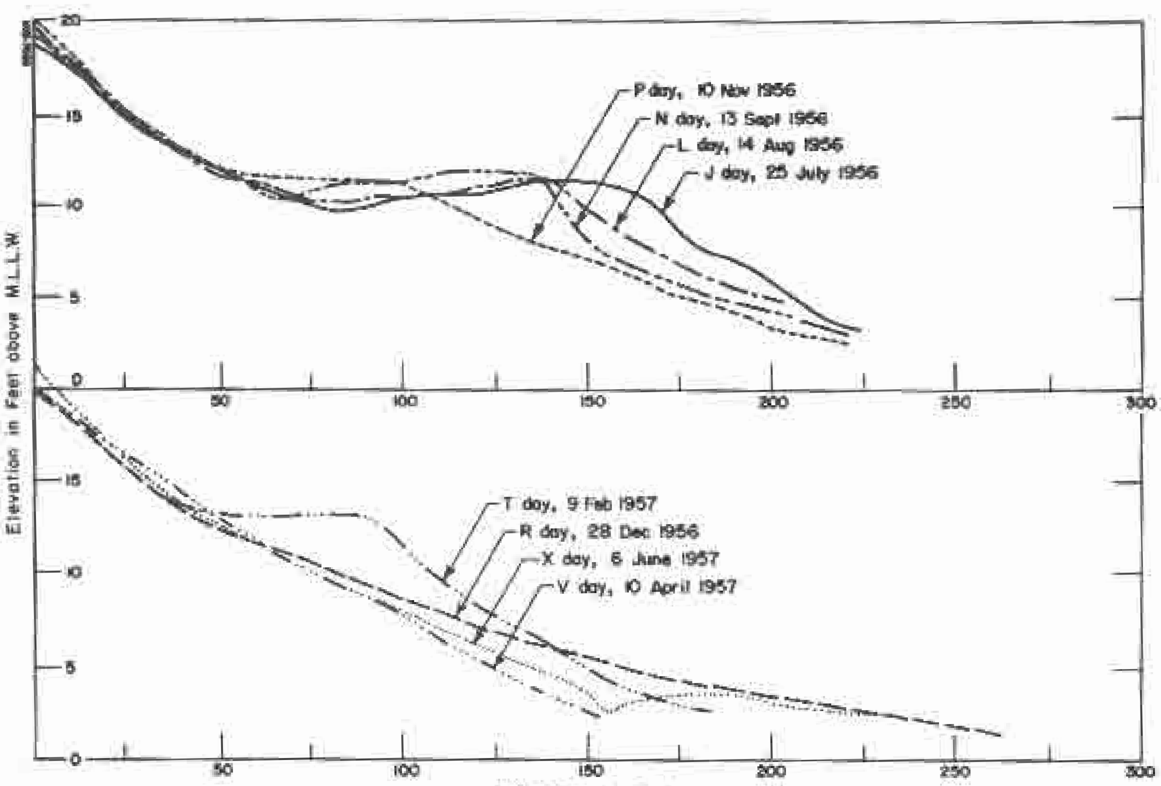

FIGURE 15. PROFILES ON LINE K, OCEAN BEACH, 1956-57

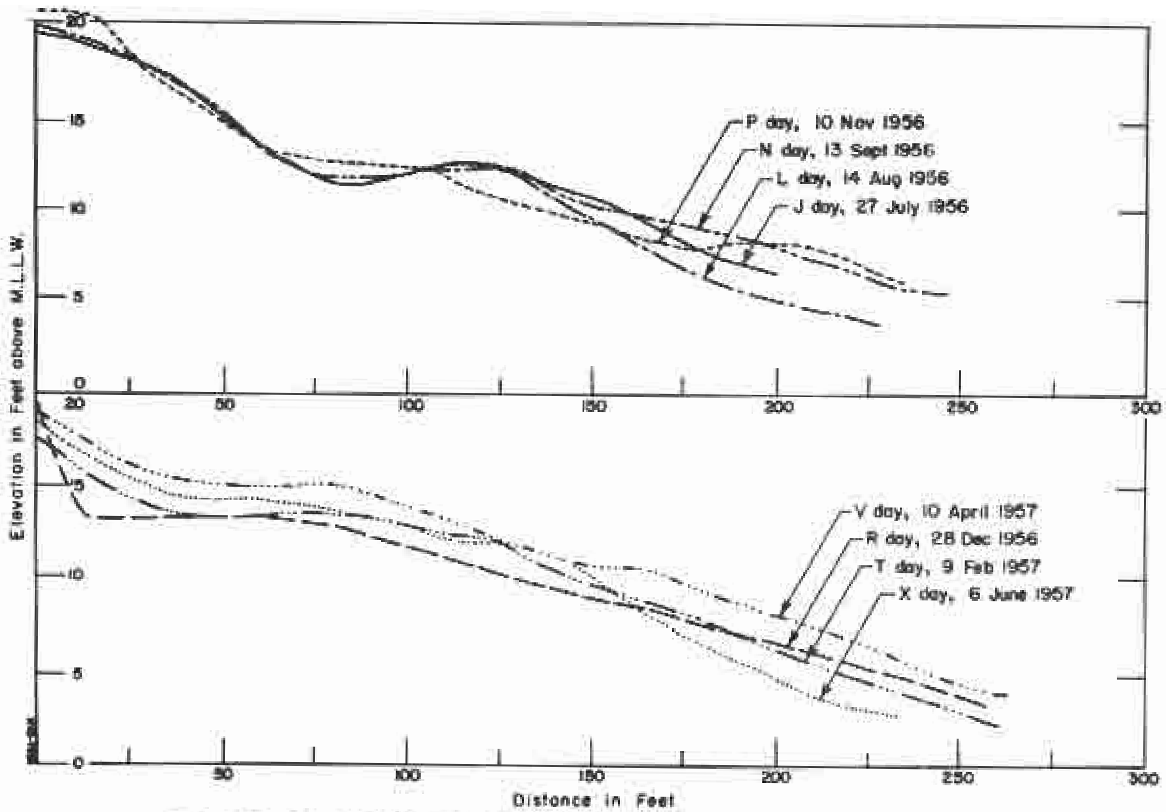

FIGURE 16. PROFILES ON LINE L, OCEAN BEACH, 1956-57

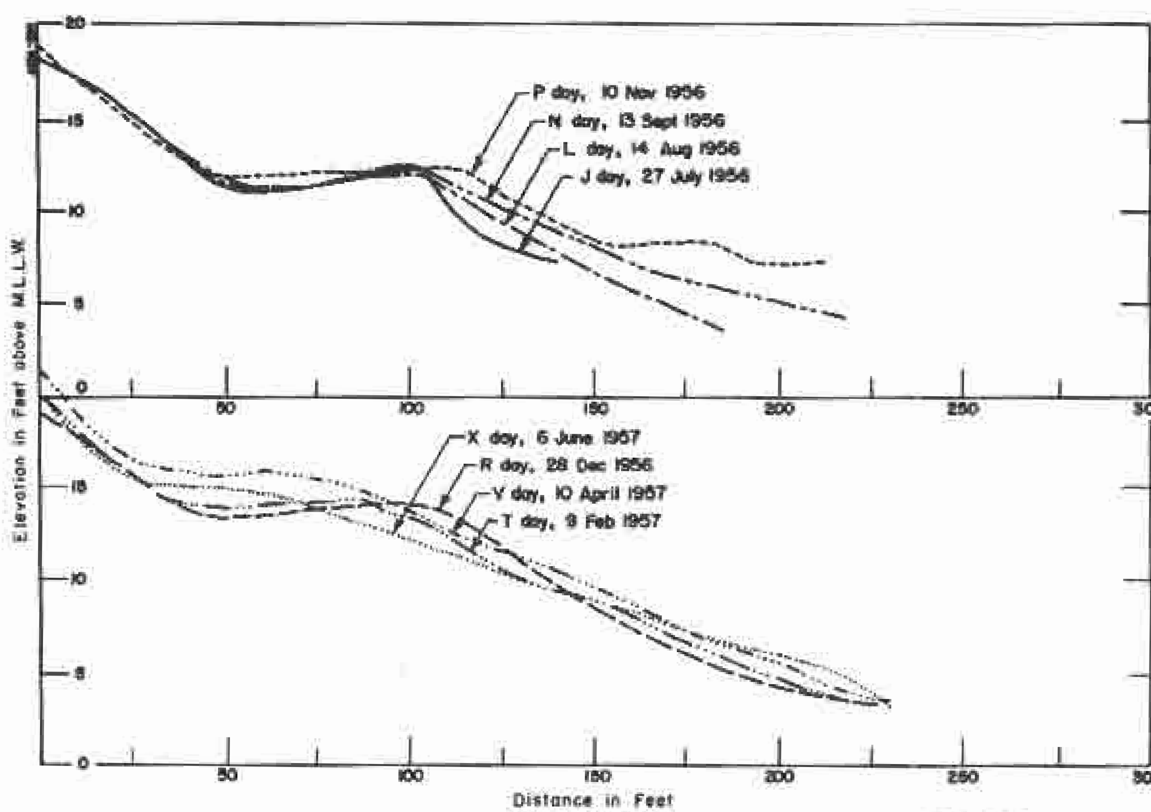

FIGURE 17. PROFILES ON LINE M, OCEAN BEACH, 1956-57

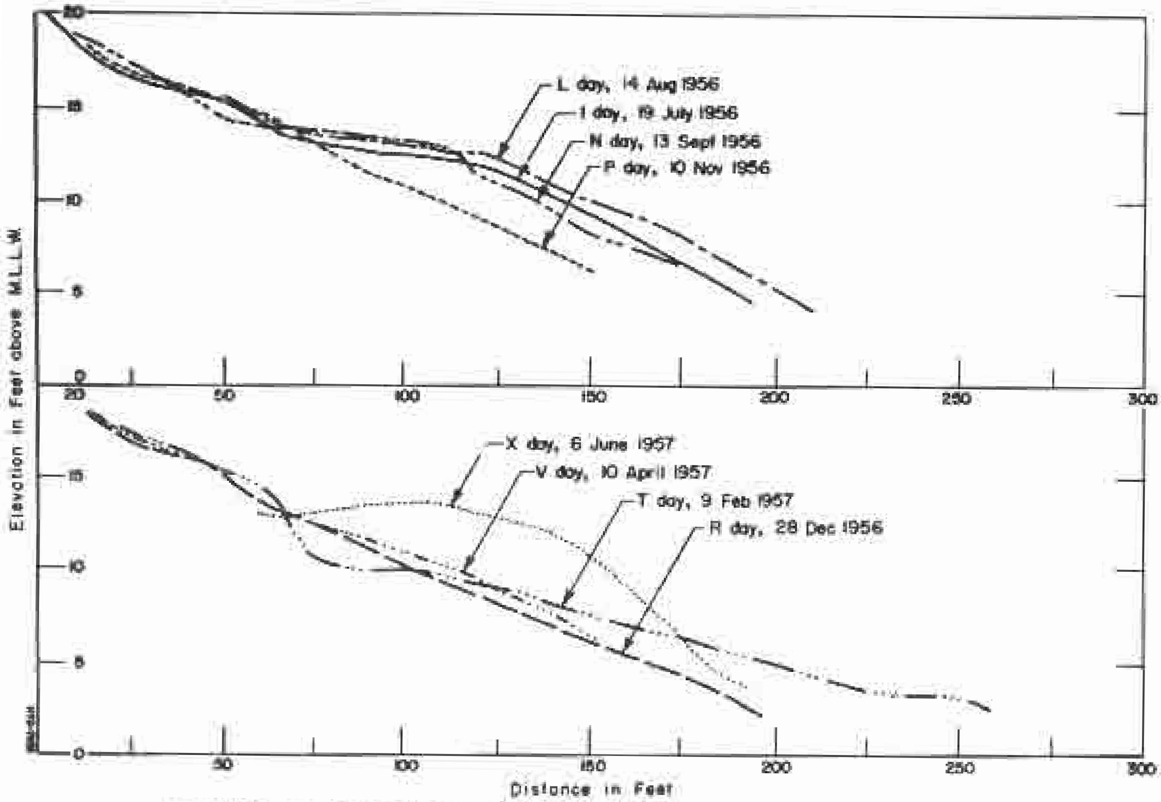

FIGURE 18. PROFILES ON LINE F, SHARP PARK, 1956-57

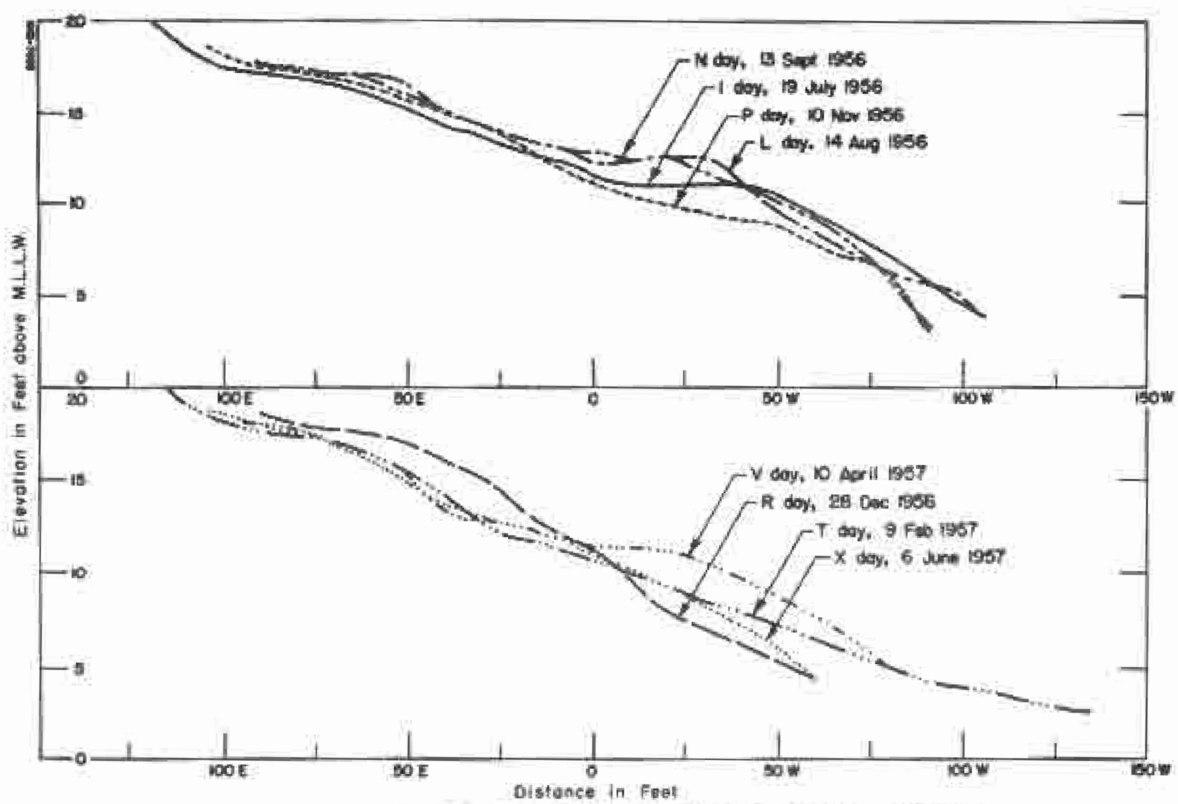

FIGURE 19. PROFILES ON LINE E, SHARP PARK, 1956-57

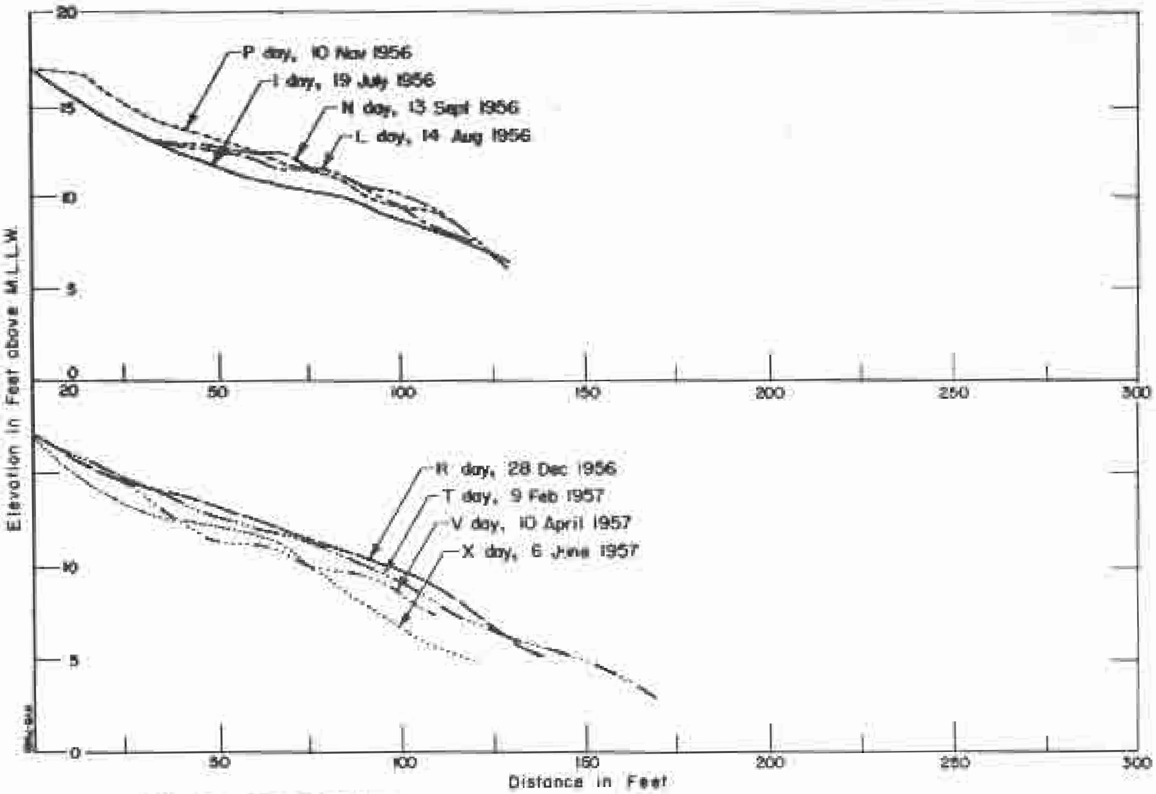

FIGURE 20. PROFILES ON LINE C, ROCKAWAY BEACH, 1956-57

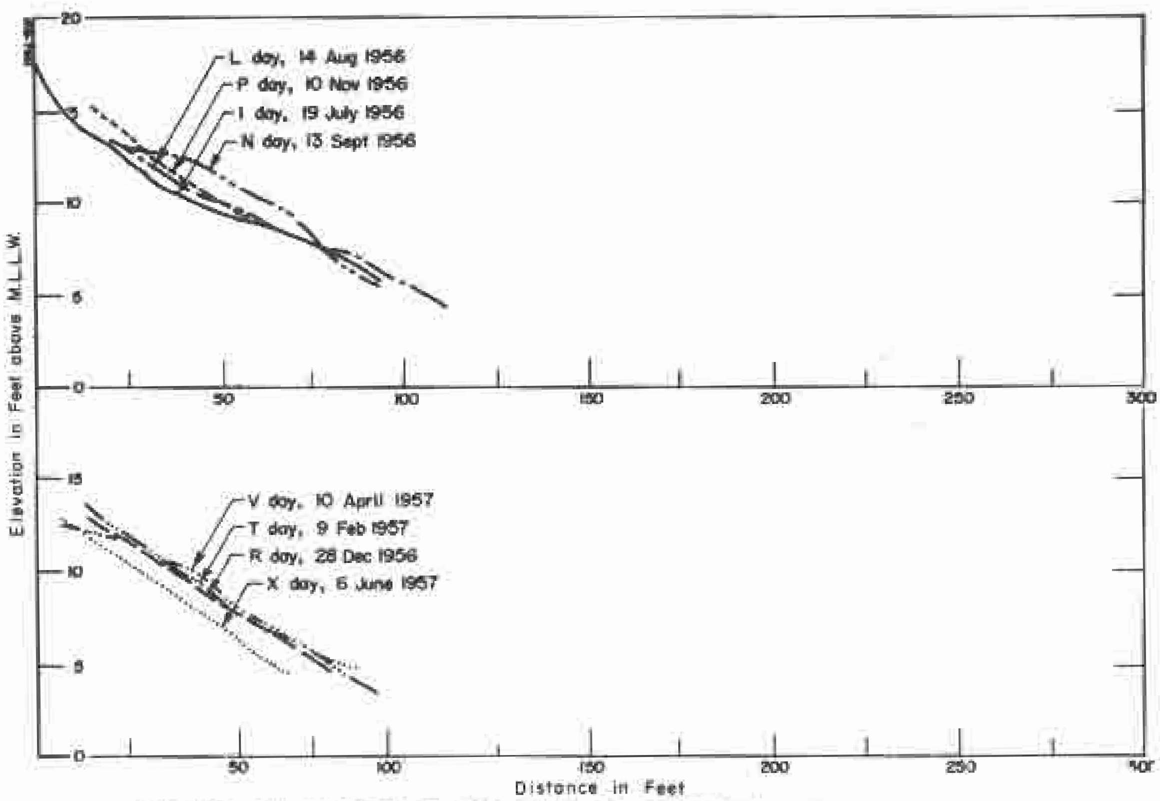

FIGURE 21. PROFILES ON LINE D, ROCKAWAY BEACH, 1956-57

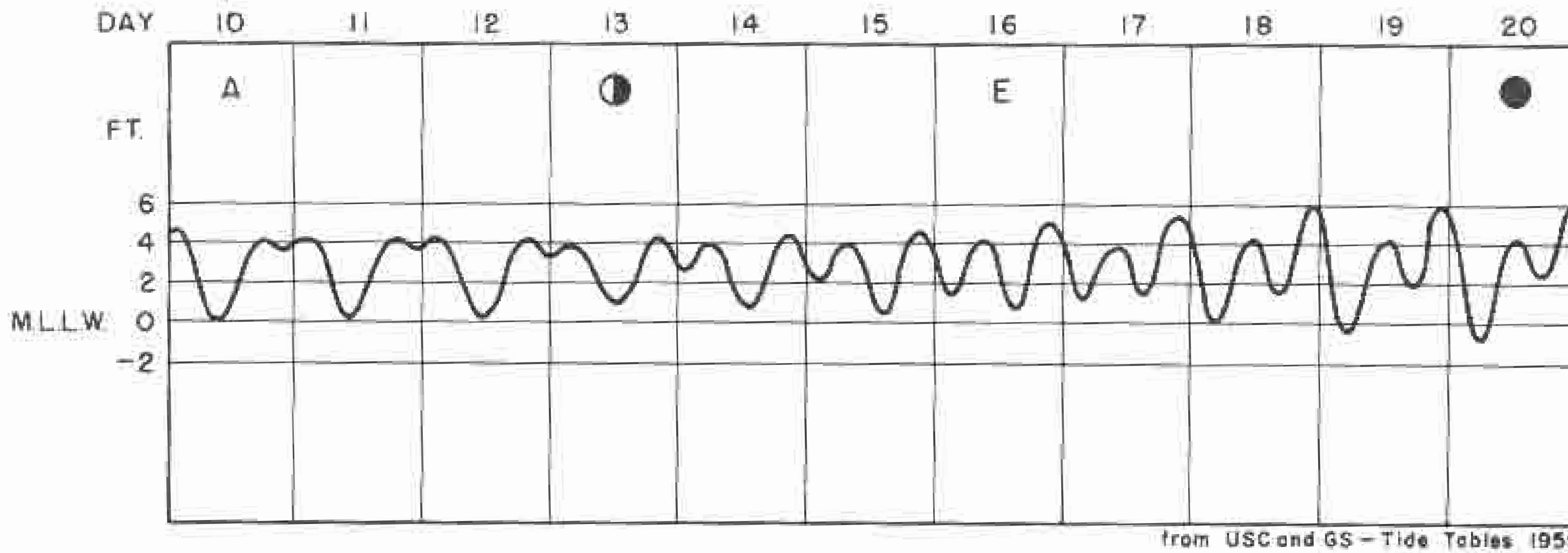

FIGURE 22. TYPICAL TIDE CURVE – SAN FRANCISCO

BEACH EROSION BOARD, C. E., U. S. ARMY, WASHINGTON, D. C.

BEACHES NEAR SAN FRANCISCO, CALIFORNIA, 1956-1957 by Parker D. Trask, April 1959, 89 pp., 22 illus., 11 tables, TECHNICAL MEMORANDUM No. 110 <u>UNCLASSIFIED</u>

1. Beach materials
2. Shore processes
3. Beaches - Calif.
4. San Francisco, California

I. Trask, P. D.
II. Title

Eighteen profiles on ocean beaches in the vicinity of San Francisco, Calif., were measured and sampled at 2 to 6-week intervals from July 1956 to June 1957, and results are presented in tables and graphs. Results show individual beaches differ from one another, and the same beach differs from season to season and from place to place at any given time. The sand on the beaches tends to be relatively fine in the fall and coarse in the late winter or early spring. Individual beaches commonly build up during summer and fall and erode back during winter and spring. The front of the berm may advance or retreat as much as 100 feet throughout the year.

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